The FOUNDRY

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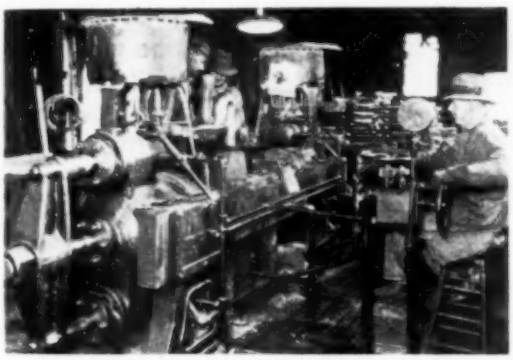
Castings Extrude Miles of Lead Pipe Daily

WHILE lead is one of the heaviest metals it possesses two properties which make it invaluable in certain industrial applications. The value of lead is enhanced by its plasticity at ordinary temperatures and its corrosion



Courtesy American Gas Association

Pipe Bends Like Lead Pipe Are Extruded in Hydraulically Operated Presses

resistance. Its plasticity is such that the metal can be formed and worked in the cold easily, and its corrosion resistance finds application in the chemical industry for conducting, holding or making certain acids; in municipal service as water service pipe; in the form of foil for wrapping certain products; in sheets for roofing houses and buildings, and in the form of cable sheathing for its probably greatest use, in underground telephone and telegraph service work. Manufacture of lead pipe, like that of the lead pipe bends shown in the accompanying illustration, is accomplished by extruding semiplastic lead through dies in large hydraulically operated machines constructed chiefly of castings. Molten lead is poured into a chamber of the machine, and allowed just to solidify. Then a ram is brought into play which forces the lead that is extremely plastic just under its solidification point, through suitable dies.

Find Where Castings Can Be Sold

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MOLDING

By Edwin Bremer

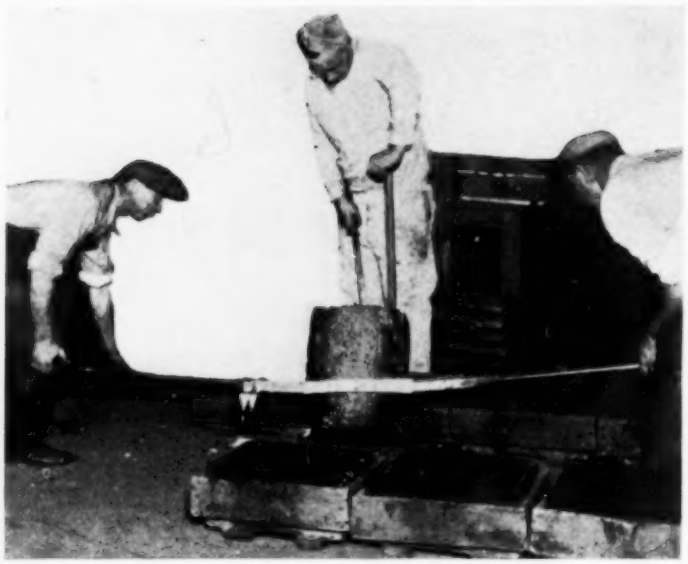


Fig. 1—Each Molder Pours His Own Floor

ALTHOUGH the Apex Electric Mfg. Co., Cleveland, was founded as the Forest City Specialties Co. in 1912, its foundry is of comparatively recent origin, having been established in 1930. The company manufactures several different models of washing machines, vacuum cleaners, electric ironers, electric refrigerators, and exercising machines. A variety of aluminum, gray iron, brass, bronze and zinc-base castings are used in constructing the various machines. Gray iron castings used by the company are purchased outside as are the permanent mold aluminum and zinc-base die castings. The Apex foundry supplies the firm's need in sand-cast aluminum, brass and bronze castings. Some experimental work also has been done with permanent mold casting, but at present only a small aluminum bearing with a graphite sleeve is made by that process.

The foundry department is located in two brick buildings about 40 feet apart which are joined by a low, covered passage. The main building, approximately 50 x 100 feet, contains molding, melting and core departments, while the second building, 30 x 60 feet, houses the cleaning, grinding, inspection and shipping departments. Metal for the castings is melted in 8 pit-type, gas-fired furnaces placed in a row in one corner of the building. Three of the furnaces contain iron pots for melting aluminum alloys, and the remaining five are used for crucible melting.

Crucibles holding molten brass or bronze are lifted from the furnaces, and skimmed carefully. Then they are carried a short distance to the pyrometer station opposite the furnaces where the temperature of the metal is determined. Knowing the temperature drop in carrying the metal from the station to the various floors, the metal is held until the correct temperature is attained, and then sent to the floor to be poured. With the aluminum, a slightly different arrangement is used. Due to the use of pit-type furnaces and iron melting pots, the molten metal is dipped from the pots with a long handled ladle and placed in a preheated crucible. The crucible and its contents are taken to the pyrometer station, and a handful of a cryolite-base flux thrown on the surface. After a few minutes, the flux is stirred into the metal, and then carefully skimmed off. The metal temperature is taken, and when the desired point is reached the crucible is carried to the floor.

Castings made in the foundry of the Apex company range in weight from a few ounces, like the

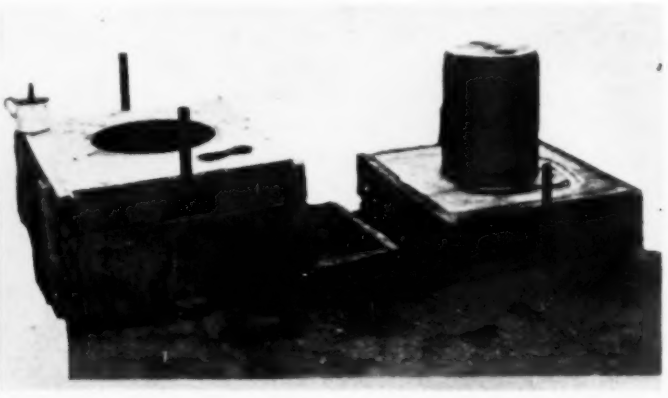


Fig. 2—Valves for the Wringerless Washers Have Thin Walls. *Fig. 3—Cheek and Drag for a Large Bushing with the Core in Place. The Gate Is at the Bottom*

NONFERROUS CASTINGS

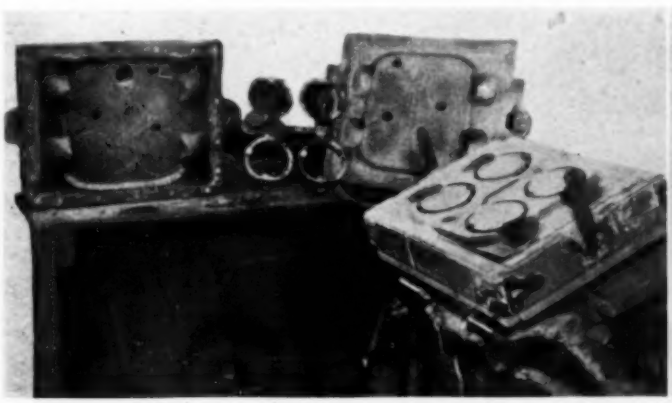
For Household Machines

valves for wringerless washing machines shown in Fig. 2, to over 100 pounds each, as typified by the bushing which is made in the mold shown in Fig. 3. Valves are produced in bronze, and as may be seen, the molds are made from a match-plate containing 14 patterns symmetrically arranged. The molds are made in snap flasks on a hand squeezer molding machine. In making the molds the drag flask is placed on the platen of the machine with the pins up, and the pattern slipped over the pins. Then the cope flask is adjusted, and the whole rolled over so that the drag flask now is on top. A layer of sand is riddled over the face of the pattern, and backing sand is shoveled in until the flask is nearly full.

Fig. 6—Gates and Risers Are Removed with a Band Saw

Then the sand is peened along the edges of the flask to insure good, firm sides for the mold. The flask is filled with backing sand and the excess sand struck off level with the edges of the flask. A bottom board, slightly smaller than the inside measurements of the flask, is placed on the top, and the whole is rolled over. That operation brings the cope flask on the top, and the procedure of filling it with sand is similar to that described for the drag flask. The excess sand is struck from the cope and a board, differing but slightly from the one used for bottom board, is placed on the sand. The top board contains a small cylindrical block on its underside which forms an impression in the sand for the sprue opening.

With the top board in place the head of the squeezer machine is swung over the mold, and the lever actuating the squeezer mechanism is pulled down. The lever is released, and the head swung back to its original position. The top board is removed, and then the cope flask is lifted with the aid of vibrator operated with a knee valve. The cope flask is placed on edge



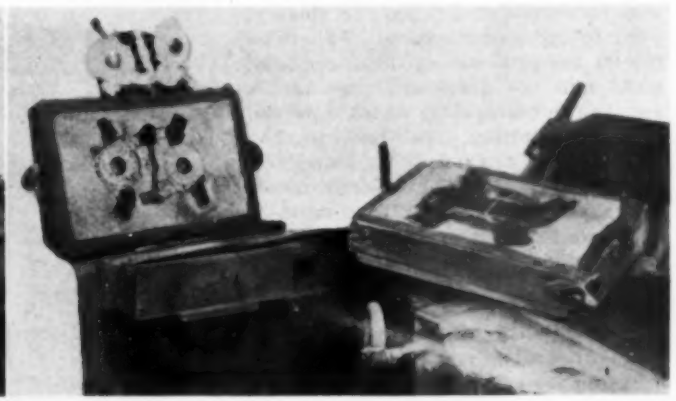


Fig. 4—Design of the Pattern Eliminates the Use of a Ramup Core To Form a Projection on the Casting. Fig. 5—Water Connections Turned End for End Are Made Two Up

on the adjoining bench, and the sprue cut through to the opposite face of the mold with a hollow brass tube or sprue cutter. The casting cavities are inspected for defects, and attention is turned to the remainder of the mold.

The pattern plate now is removed also with the aid of the vibrator, and placed to one side. The face of the drag mold and the casting cavities are examined, and any loose sand or dust is blown out with a small hand bellows. Small cores are placed in the respective cavities where they are supported by two prints. One of the prints is at the large end of the valve, and the other is at the side near the opposite end. The latter print is flat, approximately ¼ x 1 x 1-inch in size. After the cores are set, the cope is replaced upon the drag, the two flasks are unlatched, and removed as one piece. The mold resting upon its bottom board is lifted from the platen of the molding machine and placed on the floor ready for pouring. Due to the number of cores placed in the casting cavities, the average day's output per molder is between 75 and 80 molds.

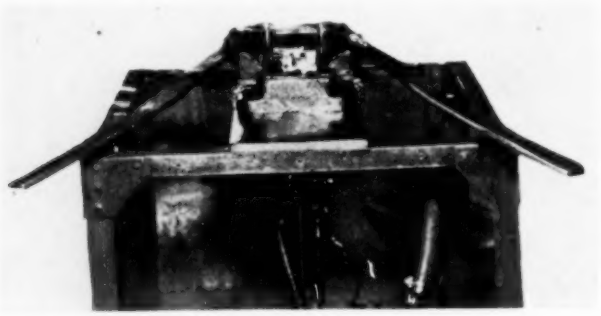


Fig. 7 — Graphite-lined Aluminum Bearings Are Made in a Metal Mold

Make Large Casting

One interesting casting made in the Apex foundry is the bronze bushing shown in Fig. 3. While it may not be considered a large casting for many foundries, it is so regarded where the production is mainly in light units. The bushing is approximately 12 x 14½ x 18 inches and will weigh about 295 pounds. As may be surmised, a three part flask is used in its manufacture. The casting is formed mainly in the cheek mold and the drag and cope molds supply the core prints which hold the core in position. In making the bushing the drag flask is placed on a bottom board, and a layer of molding sand shoveled in. The sand is rammed into place and the process continued until the sand is within 2 inches of the top of the flask. Then the wooden pattern is placed in the center which has been leveled off. A layer of sand is rammed into the remaining space, and the process continued until the flask is filled to the top.

The usual striking off is handicapped somewhat by the pattern in the center of the mold. The sand surface is slicked lightly with the trowel, and some parting compound shaken on from a bag. Then the cheek is lowered over the pins of the drag flask. A thin layer of sand is riddled evenly on the bottom of the cheek, and a number of gaggers are placed in the flask to give support to the sand. When the gaggers have been set, the mold is filled with successive layers of sand which are rammed into position.

After striking off the excess sand, the surface is slicked lightly, and dusted with parting compound. The cope flask which forms the upper print supporting the core, is lowered over the pins of the cheek, and a thin layer of sand riddled into it. Gaggers are placed strategically to support the sand, and the mold is filled with sand as has been outlined for the other mold sections. The excess sand is struck off level, and the sprue is cut with a short piece of brass tubing about 2 inches in diameter. The molder marks off the depth of the cope on the tubing, so that it only penetrates about ⅛-inch into the cheek. The cope is removed and set to one side. The sprue opening through the cheek is made with a long piece of tubing.

However, the sprue in the cheek is not located directly under that in the cope, but about 3 or 4 inches away. The two sprues are connected by a channel cut in the cheek. After the sprue and channel have been cut, the pattern is removed carefully, and the cheek lifted off as shown in Fig. 3. The molder then cuts a two-branched, semicircular runner from the point where the sprue from the cheek opens into the drag. The ends of the branches form two gates approximately opposite at the cavity, and two other gates are cut from the runners to the cavity at points about midway between the end gates and the sprue entrance.

Black the Runner

The branch runner is blacked carefully with dry plumbago applied with a brush, and the core is set in position as shown in Fig. 3. Then the interior of the cheek is blacked in a similar manner, and the cheek is placed upon the drag. The metal line on the cope is blacked, and the cope lowered onto the cheek. After clamping the three parts of the mold together, and placing a suitable weight across the cope, the mold is poured.

Fig. 9 shows the drag, matchplate cope, and a gate of castings which constitute the aluminum housings for motors attached to vacuum cleaners. The patterns are mounted two on a plate, and leave their own green sand cores which are capped with dry-sand cores that form certain projections in the rounded ends of the castings. The castings are made on a hand squeezer machine in snap flasks. As may be observed, the drag is shallow while the cope is deep as it contains the casting cavities. The cavities are gated at two points. The sprue opens into one runner which is connected at the center to the other runner. In addition to the sprue two feeding reservoirs or risers are placed on the tops of the cavities. These are formed by small cylindrical projections about ½-inch in diameter and 1½ inches long on the patterns. Cup-shaped pieces on the underside of the top board form the depressions in the upper surface of the cope which extend down to the tips of projecting

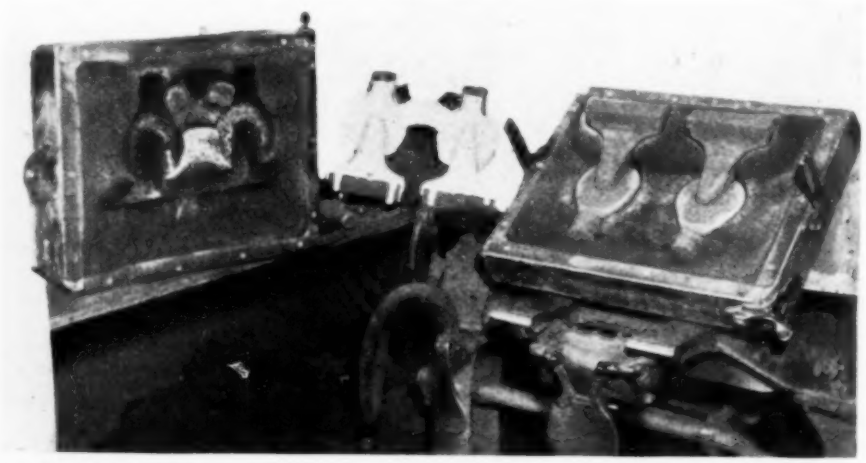


Fig. 8—Hand-type Vacuum Cleaner Nozzles Fit Nicely Two in a Flask

pins on the patterns. The average day's output per molder is from 118 to 124 molds.

Vacuum cleaners are made in two types, the standard with a handle which is pushed over the rugs or carpets, and the midget or hand type so popular for cleaning furniture, automobile upholstery, drapes, etc. The nozzles for the large cleaners, due to their size, usually are made one in a flask while the midget nozzles as shown in Fig. 8 are made two up. The illustration includes the drag mold with the cores in place, a gate of castings and the cope mold. The molds are made on a squeezer machine in snap flasks, and an average day's output ranges from 130 to 140 molds per man.

Due to the shape of the nozzles an irregular parting line is formed on the matchplate used in making the molds. The casting cavities are fed from a single sprue which opens into two short branches or gates. One of the gates is attached to the tubular opening to which later the dust bag or catcher is fastened, and the other is attached to the circular portion which will house the fan. The sprue is located centrally with respect to the two gates.

Construction Differs Slightly

In the standard or regular type vacuum cleaner two sizes are made that differ slightly in construction. One of the cleaners contains a revolving brush in the under part of the nozzle while the other does not. The nozzle containg the brush, naturally, is larger with a wider mouth opening to accommodate the brush. Both types of nozzles are made one in a mold from matchplates on hand squeezer machines. Due to the difference in size, the production per day per man is not the same for both nozzles. With the larger nozzle, the molder has to have aid in lifting the finished mold from the platen of the machine and carrying it to its place on the floor. That curtails the production to some extent, and the molder's average day's output is about 106 molds. The molds for the other nozzle can be handled by one man, and in consequence the production ranges from 120 to 124 molds per day.

Fig. 10—Cores for Vacuum Cleaner Nozzles, Motor Housings, and Water Connections Are Made in Large Quantities

Fig. 5 shows the drag mold with the cores in place, the cope mold, and a gate of castings for a water connection for the Apex company's washing machine. The molds are made from a loose pattern which is held in a hard sand match during the formation of the drag mold. As may be observed the castings are made two up, and are turned end for end. Three cores are used in forming the various openings in each casting. The castings are gated at two points as follows: One gate is attached to the tubular opening on one side of the casting cavity, while the other is attached to the body cavity close to the opposite side. The sprue opens into one of the branch gates, and the two branches are connected by a cross runner leading from the point of entrance of the sprue. An average day's output of water connection molds is about 80.

Electric mangles or ironers built by the firm require a bronze casting which is ring-shaped for supporting the roll portion of the ironer. Two molds, the matchplate, and a gate of castings utilized in making those pieces are presented in Fig. 4. The castings are made four up, and due to certain features in design, an irregular parting line is employed to eliminate the use of ram-up cores, etc. The rings or collars are approximately ½-inch thick, 1-inch deep, and 3 inches in diameter. On one face a small pin slightly larger in diameter than the casting thickness extends about ¾-inch above the face. The pin, of course, is not difficult to form as it is perpendicular to the face.

Eliminates Use of Core

However, another extension on the opposite face of the ring, and about 90 degrees removed from the pins, contains a projection on the end which is perpendicular to the side of the ring. Consequently, it forms an undercut which would prevent drawing the pattern from the sand. In similar cases a small ram-up core containing a cavity for the undercut often is used, but in this instance the additional work of making the core was eliminated by making a pocket in the drag, and forming a green sand core in the cope. The green sand core fills the drag pocket completely except at the bottom where the undercut is formed. The castings are fed from a single sprue which opens into a runner containing four gates leading to the respective casting cavities. From 108 to 110 molds constitute a day's work.

Fig. 7 shows a small permanent mold or gravity die casting machine for making graphite lined bearings used in wringers attached to washing

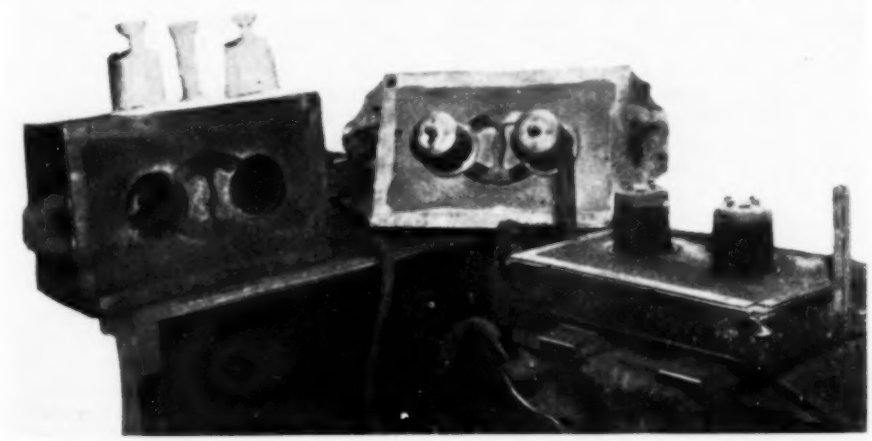


Fig. 9—Housing for the Vacuum Cleaners Are Made in Aluminum

machines. The bearings are of the cap type containing two ears for the fastening-bolt holes. They are made of aluminum, and as mentioned, contain a graphite lining which is purchased preformed as a shell about 1½ inches long, ⅛-inch wall thickness and 5/8-inch interior radius. The bearings are made two at a time; the two halves forming a complete bearing. The two parts are joined at the adjacent ears which places the two halves in one line, and the curvature of one half is reversed with respect to the other so that an S-shaped casting results.

Molds Split Vertically

That particular arrangement allows one half bearing to be made in one half of the mold, and the other in the other half of the mold. The two halves of the mold are split vertically, and the motion of opening and closing is in a horizontal plane. Opening and closing the molds is accomplished with the two levers shown in Fig. 7 which are pivoted at two points. One point is at the end of the levers, and the other is on the mold with the result that movement of the molds with respect to each other practically is parallel. The base plate on which the molds are mounted contains two pins or cores which are depressed below the top of the base plate by a treadle. The pins are located at the points of curvature of the two bearings. The pouring sprue is located centrally with respect to the two bearings and cut half in each mold.

In making a pair of bearings, the operator with the mold open, places two of the graphite shells in the proper positions on the respective pins. The mold then is closed and maintained in that position by holding the ends of the levers in one hand. The mold is filled with aluminum from a small dipper ladle, not unlike a plumber's lead ladle. The metal is obtained from a gas-fired melting pot within easy reach. The mold then is cooled with a blast of compressed air directed from a self-closing nozzle. When the metal has solidified, the mold is opened and the casting removed. The hot castings are placed in a tub of lubricating oil and allowed to remain until cool. They then are removed, allowed to drain, and sent to the cleaning department. Cooling in oil is employed to allow the porous graphite shell to become thoroughly impregnated with lubricating oil which leads to longer bearing life.

All castings are transported to the cleaning department, situated in an adjoining building, in wheelbarrows. The permanent mold castings of course, need little finishing. The main operation consists in sawing off the pouring sprue, and sawing the two bearings apart. Only a little grinding is required before placing them in stock. With the sand castings, more work is required. First the castings must be removed from the sand. If they contain cores, those are removed in the cleaning room. Then the gates are sawed off, and grinding operations remove the evidences of the gate attachment, fins, rough spots, etc.

Pours Own Molds

Labor distribution at the Apex Electrical Mfg. Co. foundry is similar to that employed in nonferrous foundries. The molder makes and pours his molds and sets his cores. The castings are shaken out and removed by laborers, who also recondition the heap sand. One melter looks after the furnaces with the assistance, when needed, of one of the laborers for charging, etc. The laborers also carry the molten metal from the furnaces to the floors, and assist in pouring and shifting weights. One laborer is employed for every four molders.

Rate Setting Needs Consideration

By A. E. Grover

SETTING of piece rates in any shop is an operation that requires careful study of all the factors connected with the production of a finished or semifinished article, for the rate established must be equitable to both the management, and the worker. Piece rates too low certainly are not fair to the worker, and while apparently such rates are favorable to the management. the reverse may be true. A large labor turnover due to dissatisfaction with the piece rates may raise the costs to such a degree as to completely overshadow the apparent advantage of a low piece rate.

While in many instances, a careful investigation by a competent time study man who is conversant with all the details of the method of manufacture, will give data upon which a fair, and equitable rate may be based, it some times happens that the proper weight is not given to one operation as compared to other operations, and the rate set is far from being equitable. To illustrate that point, the following example may be cited. A foundry was establishing piece rates for the work based on the number of molds per day that a man could produce and pour.

However, the question arose on the proper allowance for pouring as in some cases a molder poured 1000 pounds of metal while another was required to pour two or three times that quantity. The foundry does not have continuous molding, but as soon as the cupola heat is ready, all molding ceases and the men engage in pouring. The foundry operates on a 9-hour day basis and pouring consumes that latter two hours. It also was observed that while molding effort may be comparable on several jobs, the pouring varies considerably.

Thus it may be seen that while one molder pours 1000 pounds of metal into the molds he has produced in a day, other molders are required to pour two or three times as much iron for their day's work, showing that any attempt to tie up the allowed piece rate for pouring with the molding rate cannot be done practically. Therefore, there must be two separate rates used; one for molding and one for pouring. The rate for molding should be based upon an allowed time to make the mold times the current wage rate of qualified molders.

The rate for pouring should be based upon the cost of pouring iron into all kinds of molds. Care should be taken to segregate pouring tonnage costs where different methods are employed. For example there is a different cost per hundred weight when using cranes and large ladles for heavy castings than when pouring is done by small hand ladles for light castings. It is suggested that first the pouring should be classified according to the conditions surrounding the operation on different classes of work. Then make tests of the actual time required to pour each class and calculate the labor cost for each test. Add the normal burden for that kind of work to the labor cost and divide the sum by the tonnage poured. That procedure will produce the pouring cost that can be applied to each casting in costing.

To establish piece rates for pouring, divide the labor cost of each class by the tonnage poured for the castings, resulting in a class cost per hundred weight which can be used as a basis of piece work wage payment. Arrange the job time card so that the molding rate will be used in calculating molding labor cost, and the pouring cost will be entered on the same card at the tonnage rate for that class of pouring.

Like many other principles of foundry costing, common sense must be exercised. else the exact adherance to a principle may overburden the cost procedures to such an extent that the system becomes cumbersome and eventually discontinued.

Builds Patterns For Worm and Gear Wheel

By J. G. Fitzpatrick

THE usual procedure in the manufacture of patterns for a worm and gear wheel is to make a full-sized working layout. Take for instance a worm 5 inches in diameter, with a 1½-inch pitch and single right-hand thread and a worm wheel 20 1/16 inches in diameter of the same pitch, with 42 teeth, 2⅞-inches deep. The first step in making a layout is to draw a vertical center line, as *AB*, Fig. 1. With the dividers set to 10 1/32-inches, from a center located on the line *AB*, strike an arc forming the pitch circle of the wheel. Starting at the point where the center line intersects the pitch circle, strike arcs 1½-inches apart along the pitch circle thus locating the pitch centers of the teeth. Divide the pitch into 10 equal parts and proportion the involute teeth on the gear wheel as follows: Strike an arc from the point *B* with a radius equal to 10 1/32-inches plus 4 tenths of the pitch. That will give a circle, known as the addendum circle, which will locate the points of the teeth. Strike another circle with a radius equal to 10 1/32-inches minus 5 tenths of the pitch, with point *B* as the center, which will give the root circle. That locates the bottom of the teeth. Then strike arcs, with the pitch centers of the teeth as centers, with radii equal to 2 tenths of the pitch. The intersection of those arcs with the pitch circle locate the width of the teeth.

Draw Construction Circle

Strike another circle with point *B* as the center and a radius equal to the radius of the pitch circle minus 2½ tenths of the pitch. That circle is known as the construction circle. Then with the dividers set to ¼ the radius of the pitch circle, strike arcs with that radius with one leg of the dividers on the point marking the width of tooth and the other resting on a point on the construction circle as a center. Those arcs form the side of the tooth. The opposite side of the tooth is drawn in the same manner but with the radius taken in the opposite direction. Strike an arc with a ⅛-inch radius tangent with the root circle and the face of the tooth, thus completing the profile of the tooth. Thickness of the rim, width of arms, diameter and bore of hub, the shape of the plate and thickness of the ribs are proportioned and drawn according to standard practice.

Side View Constructed

To draw the side view, first lay off the critical center line, as in Fig. 2. Project the diameter of the pitch circle from the plan view on the center line of the side view and at the intersection, locate the center of the worm 1⅞-inches above the pitch circle, point *O*, Fig. 2. With a radius of 2½ inches and point *O* as a center, strike a circle forming the outer circumference of the worm. Then with a radius equal to 9 tenths of the pitch, draw the root of the worm. Draw the bore for the worm shaft 1½-inches in diameter and lay off 1 7/16-inches on both sides of the wheel center line to give the depth of the rim. Points locating the top and bottom then are projected from the plan view. The thickness of the rim, the space forming the openings between the arms, and the diameter and bore of hub also are projected. The hub is made 3⅝ inches long and all sharp corners are rounded with a ¼-inch radius. Arcs are struck from the center of the worm forming the point of the teeth, the length of the teeth, and the thickness of the rim. The points locating the chamfer on the ends of the teeth also are projected from the diameter of the pitch circle on the plan view, and from the center of the worm, radial lines were drawn to connect these points.

To complete the plan view of the worm, shown in the upper part. Fig. 1, the outside diameter; the pitch diameter; the root of the thread; the bore of the shaft, and the center line are projected from the end view, by a series of parallel lines. Since the angle of thread, which is in the form of a straight line wound around a cylinder, is the same as the hypotenuse of a triangle, whose height is equal to the circumference of the worm, and whose base is equal to the pitch of the teeth on the gear with which it is intended to mesh, a triangle shown at the extreme left of Fig. 1, 15.7 inches high and with a 1.5-inch base is constructed. With the dividers set to 1½-inches, starting at the point where the horizontal pitch line of the worm crosses the vertical center line of the plan view, points are stepped off on either side, along the worm pitch line. With the protractor set to the angle of the hypotenuse and the base of the triangle, diagonal lines running upward from left to right, are drawn through those points thus locating the pitch centers on the opposite side of the view. Since the width of the thread and that of the tooth is the same at the pitch line, a distance of two tenths of the pitch is laid off on either side of the centers. Lines then are drawn through those points parallel to the tooth center line giving the breadth of the tooth. With the protractor, set to an agle of 75 degrees with the horizontal, the sides of the teeth are drawn. To complete the profile, a ⅛-inch fillet is drawn at the root of the thread and diagonal lines between the roots of the teeth are drawn. The continuation of the helix is shown by dotted lines.

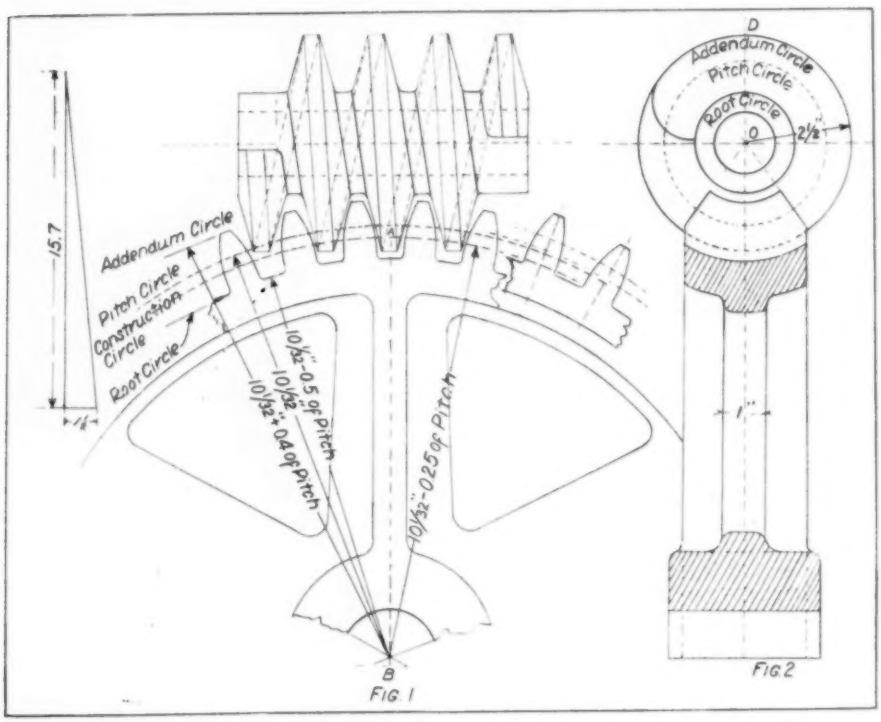
The plan view shows the teeth in working contact at the center of the horizontal plane but as the pitch circle of the teeth on the gear is drawn on a radius through the vertical plane, the pitch diameter and chordal pitch is greater at the outer edges of the teeth. To show this condition, it is necessary to cut away the upper half of the pattern for the length of the worm. A part of the rim and two teeth on the outside face of the pattern are shown at the upper right of the plan view, Fig. 1.

White Pine Is Used

Two pieces of straight grained, dry, white pine, 12 inches long, 5½-inches wide, and 2¾-inches thick are sawed and jointed. Two brass dowells are inserted in the joint about six inches apart. Metal center plates are fastened on to the ends, the corners of the block chamfered, and the piece mounted in the lathe. The pattern then is turned to 5 inches in diameter and 6¾-inches long. Core prints 1¼-inches in diameter, 1½-inches long, and chamfered on the

ends also are turned. The pattern is sanded, and the core prints given a coat of orange shellac. When dry, the prints are sanded again.

A piece of white paper, 15.7 inches long, and 6.75 inches wide is cut. The former dimension is obtained by multiplying the diameter of the worm by 3.1416, and the latter figure is the length of the pattern body. Lines are spaced 1½-inches apart across the 6.75-inch width and drawn diagonally upward from right to left, on the same angle as the hypothenuse of the triangle, Fig. 3. Similar lines spaced at intervals ⅜-inch, and parallel to the previous lines also are drawn marking the thickness of the thread at the point. A small amount of glue is placed on the edge of the paper, and the paper is wrapped around the body, beginning at the joint of the pattern with the lines showing. As the ends approach each other, a little glue is placed on the other end, and the paper is fastened to the pattern.



Figs. 1 and 2—From a Patternmaker's Full Size Layout of a Worm Gear 20.0125 Inches Pitch Diameter, 1.5-Inch Pitch, 42 Teeth, 2 7/8 Inches Deep, and a Worm 5 Inches Diameter, 1.5 Inches Pitch, Right Hand, Single Thread, Plan and Side Sectional Views

Teeth Are Cut

Two strips of wood, 4 inches longer than the tennon saw blade, 1¼-inches wide, and ¼-inch thick, are cut. These are fastened on either side of the blade by wood screws at a distance from its cutting edge, equal to the depth of the worm thread. The paper between the lines is cut away with a sharp knife, and the cut made deep enough to leave a mark on the pattern, thus marking the pathway of the thread. A template, shown in Fig. 6, is made to fit the space between the thread, the sides of which are cut on an angle of 75 degrees. Holding the tennon saw on this angle, a cut is made on either side of the thread, the strips of wood fastened to the blade regulating the depth of cut. Much of the stock is removed easily in this manner. Threads then are finished with gouge and chisel, using the template to insure accuracy. After the threads are finished, the pattern is placed in the lathe, and with the machine running at a slow speed, the sides of the thread are sandpapered. This makes a smooth, even surface, which is given a coat of orange shellac, is allowed to dry, again is sanded, and then is given a final coat of shellac. The pattern is removed from the lathe, and the ends of the core prints are trimmed and shellaced.

The plan view of the web is shown at Fig. 8, and the section of the two halves of the pattern is shown in Fig. 5. A wooden faceplate, 20 inches in diameter, is attached to the iron chuck, mounted in the lathe and faced true. The wooden plate then is divided into six equal parts and the radial lines carried across its surface. A 16-inch diameter circle is inscribed on the face of the wooden plate and strips of newspaper, about 5 inches wide, are glued over those lines. Twelve pieces of wood, 9½-inches long and 3¾-inches wide, are prepared. Six are planed to 13/16-inch, and six to ½-inch thick. The gage is set to 1⅜-inch, and a center line marked on each piece. With the aid of a bevel set to 60 degrees one end of each piece is marked with lines at that angle, and the piece chamfered along those lines to a point at its center. The outline of the arm, as shown in Fig. 8, is marked on the face of each, and the pieces are trimmed to shape. The six arms 13/16-inch thick, are butt jointed at the center, and nailed temporarily over the center lines, on the faceplate.

Segments Make Line

Twelve segments, each one sixth of a circle, with an outside diameter of 20½-inches, and an inside diameter of 16 inches, are sawed. Six of these are planed to 13/16-inch thick, and the others to ½-inch thick. The pieces are notched out at the ends, and fitted between the arms. Those pieces 13/16-inch thick match the thickness of the arms, and are set in position, with the inner radius coinciding, with the 16-inch circle on the faceplate. When all are fitted, each arm is lifted in turn a few spots of glue placed on the paper, and the arm is put back into place. Twenty-four segments 9/16-inch thick with the same outside and inside diameters as those on the plate are prepared. Two rows are glued to the face of the rim with their joints overlapping those on the plate. The hub is sawed 6 inches in diameter, 1⅜-inches thick, and is glued and screwed permanently into place, materially reinforcing the plate. When dry, the inside of the rim is turned to 17¼-inches diameter at the top and 16 inches diameter at the bottom. The rim is faced to a depth of 15/16-inch, the hub to 5 inches in diameter and 15/16-inch thick. A ½-inch fillet is made to blend with the plate. The pattern then is sanded, given a coat of orange shellac, and again is sanded. The cutting edge of a wood chisel is forced between the pattern and the faceplate, and the pattern is removed without breaking.

The opposing half pattern is built in the same way, with the exception that the web is ½-inch thick. Three blocks of wood, 3 inches long, 2 inches wide, and 1½-inches thick spaced equi-distantly are fastened to the faceplate by wood screws. The outer faces of the blocks are turned to a diameter to fit tightly to the rim of the gear, and form a chuck on which the outside rim and joint of pattern is turned. The half pattern with the ½-inch web is secured to the chuck from the back by wood screws and the diameter roughed off. Two circles, 16¾-inches and 17¾-inches in diameter are marked on the back of the half pattern and the space between them is counterbored to a depth of ¼-inch. A draft of 1/16-

inch is made on each side, and a circle 18¼-inches is marked on the rear of the half pattern. With a template made to fit the vertical radius, see Fig. 4, the outer face of the rim is finished. The pattern is sanded and all except the vertical outside of the rim, is given a coat of shellac. When dry the pattern again is sanded, removed from the chuck, and the other half pattern mounted in its place.

The outside face is roughed off. Two circles, 17⅞ and 16⅝-inches in diameter are inscribed on the joint, and the surface toward the center and outward toward the rim front of those lines is turned down for a distance of ¼-inch. This leaves a projection which, on being faced down to 3/16ths and chamfered so as to fit into the recess turned out on the joint of the opposing half holds the two halves of the pattern in proper relation to each other. The diameter, at the bottom of the vertical radius, is marked on the joint and with the aid of the template, the outer face is turned, sanded and finished, in the same way as the opposite half.

Cut Blocks for Teeth

From a piece of straight grained mahogany, 42 blocks are cut 3½-inches long, 1⅞-inches wide, and 1 inch thick. The rim is divided into 42 equal parts. A bevel is set to the angle of the worm thread and diagonal lines are drawn across the face of the rim through the 42 points locating the centers and angle of the teeth. The half patterns are joined, the points marked, and the diagonal lines continued across the opposite rim. A thin straightedge is nailed to one line by two small brads. The rim is covered with blue chalk in the vicinity of this line and each block is fitted to the face. While the blocks are in this position, the angles at the ends and in the center are marked. The blocks then are cut in two on the angle through the center, and the ends trimmed, but left long enough to extend 1/16-inch over the joint and outside edge of the rim.

The halves are separated, each block is set to the edge of a diagonal line, and glued permanently into place. When dry, V-shaped pieces of white pine, about ⅜-inch thick, are glued between the blocks flush with the joint end. These pieces prevent the blocks from chattering and the edges from breaking while being turned level for marking the curve of the teeth. The blocks are turned flush with the pattern joints, sanded, and shellaced, and when dry, again are sanded. The pattern halves are assembled and held together by wood screws. V-shaped pieces of pine ⅞-inch thick are glued between the blocks, flush with the ends. When dry, the ends and points of the teeth are turned and finished to template. The pattern is sanded, given a coat of shellac, and when dry again is sanded and the pattern parted.

The pitch and construction circles are marked on the outside and inside faces of the teeth. With the dividers set to 1½-inches, the pitch centers are located, and the points, for the width of tooth at the pitch line, are marked. With the dividers set to one-fourth the radius of the pitch circle and one leg resting on the construction circle, the curves of the teeth are struck. The V-shaped pieces are sawed out and the teeth are trimmed to shape using a straightedge from root to face. The two halves of the pattern are joined and the teeth made to match.

A portion of the projection on the joint of the pattern, about 1½-inches long and with ends slightly bevelled, is cut away flush with the joint. A piece of hard wood of the same thickness, trimmed to the same outline is fitted into the space. The halves are placed in apposition, the teeth in line, and the recessed half at the bottom. The upper half is tapped lightly, the pattern is parted, and the loose portion left in position in the lower half. Here, it is glued permanently, and forms a check to keep the halves in correct position. The ribs are fitted, glued and screwed into place. Half-inch leather fillets are made to blend with the plate, and the corners are rounded and sanded.

When the worm is placed in contact with the gear, it is found that the teeth, at the pitch line, do not mesh. This is because the pitch line on the gear was struck on a radius. As a result the pitch circle and the chordal pitch is greater at the ends of the teeth than at the center. To overcome this, a part of the face at the ends of the gear teeth is pared off. If the dividers are set to the overall distance of the number of teeth on the worm that should be in contact at the same time, and this dimension compared with the overall distance at the end of the same number of teeth on the gear, the latter is found to be the greater. Therefore, one-half of this difference is pared off each face, tapering to nothing at the center. The pair then will mesh. The teeth are sanded at the roots, ⅛-inch leather fillets are glued, and with the ribs, are given a coat of shellac. When dry they again are sanded and the complete pattern given a final coat of shellac after which it is ready for use.

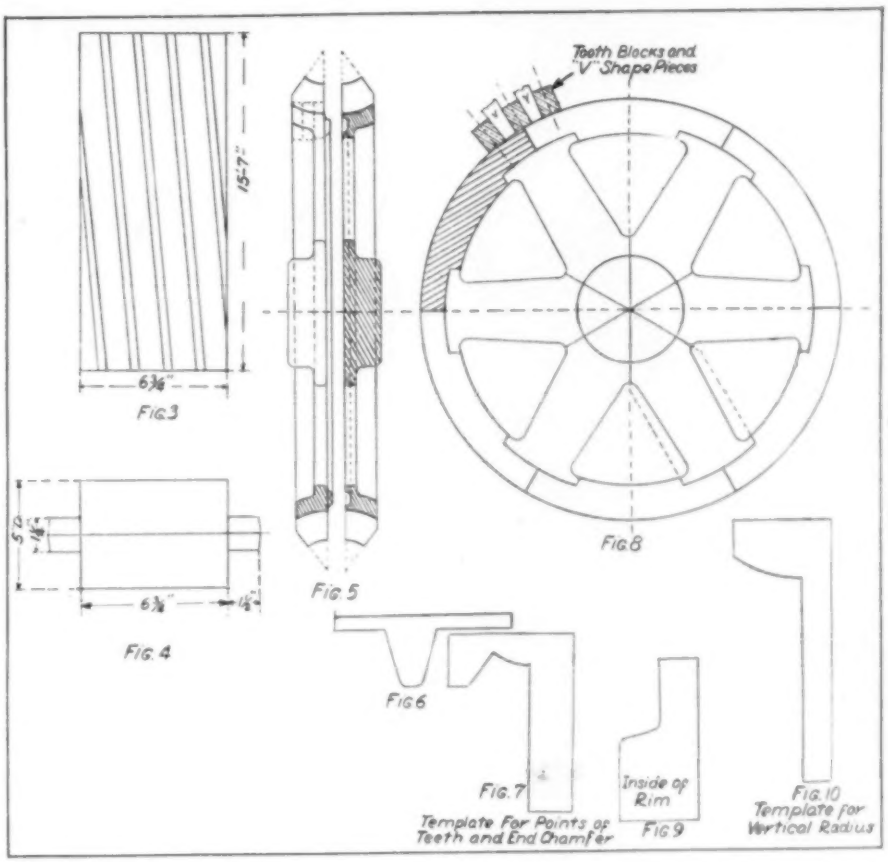


Fig. 3—A Strip of Paper Shows the Thread. Fig. 4—Worm Cylinder on Which Thread Is Cut. Fig. 5—Halves of the Wheel Pattern Are Fitted with a Circular Guide. Fig. 6—Templet for the Thread. Fig. 7—Templet for Points of Teeth and End Chamfer. Fig. 8—Showing Detail of Body and Tooth Construction. Fig. 9—Shape Inside the Rim. Fig. 10—Templet for Shaping the Tooth Face on the Wheel

Pouring Iron Into a Roll Mold

Clean Iron and Steel With Alloying Agents

By R. C. Good

OF ALL the alloys used in the iron and steel industry, silicon and manganese receive the most attention by the operator. These alloys, acting as scavenging agents, combine with oxides and gases, and when added in sufficient amounts dissolve in the iron and impart distinct characteristics that may be obtained in no other way at the same cost.

When silicon is added to cast iron, the softening and graphitizing effect usually is the only influence considered by the operator. In general, it has been shown on numerous occasions that definite percentages limit the thickness of the casting that will appear gray after solidification. The operator is inclined to give far more thought to this function of silicon than to its affinity for oxygen.

Assuming the presence of free oxygen in the cupola or combined oxygen as carbon monoxide or carbon dioxide, an ideal condition exists in the melting zone for the combination of silicon and oxygen, resulting in the formation of SiO_2. This compound is refractory in nature and is removed only with difficulty. It is believed that this oxide of silicon which may be formed early will, under special conditions, recombine with carbon monoxide, forming pure or nascent silicon which is extremely active.

It is quite possible both to oxidize and reduce silicon in a cupola which operates with extremely hot melting zones. Irrespective of conditions prevailing in the cupola, whether only the first or both reactions occur, the final metal will possess properties other than were anticipated according to analysis of the iron.

Silicon Has Several Forms

It should be remembered that an ordinary analysis of iron for silicon does not show how silicon exists, for usual chemical analysis involves oxidation of that element. Consequently, an original percentage of silica will be added to that found as silicon and pass unnoticed, later being reported by the chemist as silicon. In one investigation recently made by our laboratory for silica, that compound was found by a special analysis to be 0.80 per cent of the iron.

Silica exerts no graphitizing effect with the result that thin sections of iron chill and trouble develops in the machine shop. The effect of silica on the chilling properties is, of course, important, but presence of silica as foreign inclusions decreases machinability, ductility and ultimate strength of the iron.

In those cases where silicon is oxidized and then reduced as nascent silicon, we have a condition occasionly found in the electric steel foundry, termed *over reduction*. This quality is recognized easily by rapidity of solidification of the material in the molds; and in some extreme cases, the metal will throw off a gas previously held in solution by the silicon, which forces some of the remaining molten metal up into the gates and risers. That condition is not found as often in the iron foundry as in the steel foundry where the metal has been heated to much higher temperatures and is exposed at these temperatures to the atmosphere.

Recently, a plan was devised to incorporate silicon in a way that approaches a molten addition of silicon to the iron when melted. It involves the use of silicon briquets in the charge of the cupola. The silicon is covered with a protective binder until the melting zone is reached, when the silicon is released and drops into the metal in the crucible. Chilling of the metal by ladle additions is eliminated, and other advantages of the practice probably have been mentioned before. Briquets of manganese and chromium also have been prepared for similar uses. Through use of the briquets, alloy recovery is high and there is no possibility for reactions described previously to develop.

Degasifies the Metal

Effect of silicon in iron in quantities up to 0.50 per cent is one of degasification. Above that point, silicon raises the fusion point and also causes the precipitation of graphitic carbon when the metal passes through the graphitizing temperature range. Amount and size of graphitic carbon which separates depends more on the time that the iron is held in that temperature range than it does upon silicon content. Several methods have been devised to take advantage of that natural law, such as superheating the metal and casting it into cold molds, or pouring iron at normal temperatures into heated molds.

Another plan used to control the precipitation of graphite involves a ladle addition of combination alloys of silicon with calcium, manganese or zirconium or other elements which have a strong affinity for oxygen. Using any one of these practices, it is possible to obtain gray

castings that under ordinary conditions will appear white in thin sections.

An experiment with a ladle addition of zirconium-manganese-silicon has proven successful. Several globe valves were cast and tested to destruction under hydraulic pressure, and failure occurred at pressures considerably above those necessary for good cast iron. Affinity of zirconium for oxygen and nitrogen is well known. Less is known about zirconium as an alloying agent although its value as a substitute for manganese and its ability to counteract the detrimental influence of sulphur have been determined definitely.

Sulphur May Harden Iron

Before disgressing too far from the cupola and the effects of various additional agents, consider briefly some of the observations made in former years.

Aluminum increases solidity and fluidity, refines the grain, precipitates graphite and generates heat when it combines with the oxides. However, treated metal exhibits a tendency to expel these oxides to the outside and spoil the casting surface.

In small quantities manganese actually softens cast iron. Above 0.60 per cent, it imparts toughnes; and above 1.25 per cent hardness increases rapidly. Manganese counteracts the effect of high sulphur, and when added in sufficient quantities to influence the chill, a fractured surface shows a peculiar fibrous contact between chilled and gray sections.

Sulphur as a hardening agent is determined mainly by the amount of silicon present, its effects being emphasized as the silicon decreases. A. Lissner advises 0.28 per cent silicon counteracts 0.05 per cent sulphur in malleable iron. Although many producers of rolls favor the use of sulphur as a hardening agent, much care is necessary as sulphur decreases the ultimate strength and deflection of the casting.

Vanadium is a powerful scavenging agent. It also unites with nitrogen, thereby toughening the metal and raising its shock resistance. Vanadium combines with carbon forming carbides which resist the effect of increased temperatures. White irons produced with vanadium additions resist spalling far better than ordinary white iron yet file with greater ease. Usually an addition of 0.15 per cent is sufficient to accomplish these results and increase the tensile strength.

Zirconium is a softening or graphitizing agent when added in small quantities. The size of the graphite flakes are decreased with subsequent improvement in tensile and impact strength. As a deoxidizer and denitrogenizer, it cleanses the metal. From 0.10 to 0.20 per cent is frequently sufficient to effect an improvement.

During the past decade many steel foundries have adopted the electric furnace as a melting medium. Usually the acid bottom is used in steel foundry practice because sand as a refractory, results in a low net cost to the operators. It should also be noted that acid steel sometimes has been considered superior to basic steel, a factor that influenced the custom. Because sulphur and phosphorus cannot be diminished in acid melting the original charge must be regulated with respect to those elements.

Summarize Opinions

WITH the increasing amount of literature published on iron and steel, it is difficult to keep in mind all the developments that have taken or are taking place. For that reason a summary of opinion is of considerable value. This article, which is abstracted from a paper presented at a Cleveland meeting of the Ohio Foundries association, deals with the effect of alloys on iron and steel with particular reference to those alloys acting as scavenging agents. The author is metallurgical engineer, Electro Metallurgical Sales Corp., New York.

High temperatures, fluid metal and degasified metal are essential for the production of satisfactory light castings in green sand molds. Larger castings weighing 5 tons or more generally are produced by melting the steel in an open-hearth furnace. The same reactions can be developed in either unit and the following considerations apply to either case.

Is Simplest Method

Probably the simplest method to be followed in acid electric furnace practice is to melt the charge, raise the temperature, add ferrosilicon, ferromanganese, tap and use aluminum in the shank ladles. Such steel will pass physical requirements occasionally when individual test bars are cast without aluminum, but the average results are far from satisfactory.

It might be contended that an acid slag has no other function than to protect the metal from the air and consequently requires little attention. On the other hand, it might be claimed that the greatest interest should be devoted to the color of the slag when a sample is chilled, without regard for the reactions that take place so rapidly in the metal. We do not agree that either attitude is justified in a shop directing all efforts toward the production of uniform high strength castings accompanied by good ductility.

The following plan of procedure for acid electric furnace practice is the development of several years' study combined with observations in foundries from coast to coast. Generally the charge in acid furnaces should be so regulated that the carbon, when melted, is above that required before alloy additions are made. This method will demand additions of iron ore or mill scale to oxidize the carbon.

Silicon Is Oxidized

When such additions are made any silicon remaining in the metal will combine with oxygen ahead of the carbon and an excess over that required to oxidize carbon will be needed. The oxidation of silicon is a desirable practice as this action is accompanied by a boil that promotes removal of solid inclusions. It also prevents an absorption of gas from the atmosphere above the metal that often causes rising metal in the molds.

After the oxidation of silicon and some of the carbon, additions of burned lime are made to the slag and ferromanganese (0.10 to 0.15 per cent manganese) is added to the metal. Two reactions occur immediately; the iron oxide in the slag is replaced by calcium oxide which lowers the carbon further, and the oxidation of manganese supplies a fluxing agent for particles of silica remaining in the metal; the manganese silicate so formed floats upward to be dissolved in the slag increasing its fluidity. Temperature of the metal should be raised simultaneously with these reactions so that it can be tapped as soon as silicon and manganese have been added. Otherwise the beneficial results of this practice will be reduced to some extent.

The practice is one of cleansing the metal, adjusting the slag, alloying and tapping. It results in solid castings with excellent ductility. Some improvements on that practice can be made by lowering the carbon first below that necessary, adding carbon, then ferromanganese, etc. Another variation proven beneficial includes the use of silico manganese alloys as a final addition. An alloy with approximately four parts of manganese to one of silicon, as silico-manganese, is helpful as the oxides formed are large and fusible. Another variation involves the use of combinations of silicon with zirconium or aluminum or with aluminum and manganese.

What should be added to the ladle when tapping to counteract oxidation by the atmosphere? Numerous tests have been made and in view of the necessity for some agent to take

care of mold gases generated in green sand molds, we believe some alloy should be used.

Combinations of aluminum, manganese and silicon have been successfully adopted; silicon-zirconium is excellent in high manganese or high carbon steels as an aid to machinability and shock resistance; calcium-silicide and calcium-manganese-silicon will show the greatest improvements when the steel treated contains unusual amounts of SiO_2 developed from bottom trouble or dirty scrap, etc. Aluminum and silicon should be used with caution because of the three combination silicates that may be formed there is one which requires heat to hold together; later, when cooling this silicate may separate leaving free particles of Al_2O_3 and SiO_2.

Describes Basic Reaction

Similar lines of thought may be applied with equally good results to other melting operations. For instance, in the basic electric furnace, it is highly desirable to cleanse the steel first before making additions of alloys. There are short cuts that can be followed in this practice as well as any other, but usually trouble develops eventually as the grades of steel being produced are increased.

While there are fewer basic electric furnaces than acid furnaces in use for foundry work, a description of the reactions intentionally developed will perhaps aid others in their application of reason to practice.

Cast steel with both light and heavy sections necessarily must be poured at elevated temperatures, and as this generally intensifies the injurious effects of nonmetallic inclusions, it behooves all of us to bend our efforts toward the elimination of inclusions. The rate of rise of foreign substances in a steel bath depends on their specific gravity and size. Therefore, our attention toward their formation and elimination is of paramount interest.

After melting the charge beneath a lime slag in a basic electric furnace, an adjustment of carbon is obtained by iron ore additions which also oxidize silicon forming a certain amount of silicates similar to the addition in an acid furnace. Phosphorus is oxidized and combines with the slag during this operation forming tetraphosphate of lime. By removing the slag and building a new one of lime, spar and coke, we start reduction of oxides and gases in steel.

Additions of silicon to the metal at this stage undoubtedly promote and hasten deoxidation but results of such treatment may be disastrous particularly if the temperature is increased after appreciable quantities of silicon have been used. A better practice is to add manganese. It combines with oxygen, fluxes particles of silica, rises to the surface and is reduced by the carbide slag permitting the manganese to reenter the steel and repeat its function. No addition of silicon should be made to the metal until it has been scavenged of oxides by the manganese and slag.

Other slags may be used instead of calcium carbide such as calcium silicate produced with lime, crushed silicon and spar or calcium silicon. The latter two are used only in the production of special steels while all three are applicable only to the basic furnace as the high lime content would attack and corrode an acid lining. Special alloys such as calcium silicide, calcium-aluminum-silicon and calcium carbide all have been applied successfully to production of the second slags.

Through a study of slag compositions at Washington some years ago, several interesting rules more or less were determined that have been helpful in deciding what alloys will be most beneficial in cleansing iron and steel. For instance, a slag of 30 per cent CaO, 40 per cent Al_2O_3, and 30 per cent SiO_2; or 40 per cent Al_2O_3, 30 per cent MnO, 30 per cent SiO_2 has a lower melting point than any other combination of the oxides.

Decreases Oxide Content

An analysis of the inclusions found in steel furnish a basis for further additions. In one comparative test with basic open-hearth steel, additions of aluminum decreased FeO content of the steel about 90 per cent. In another test the effect of zirconium was noted on the percentage of MnO. Here the decrease from 0.018 per cent to 0.002 per cent from furnace to ingot caused many favorable comments. Incidentally, calculations with calcium-manganese-silicon indicate exceptionally clean steel can be made following its addition to a steel previously cleansed of the major proportion of oxides with silico-spiegel or silico-manganese.

Finally, it should be emphasized that no single or combination alloy will serve as a panacea, but each one functions particularly well under conditions which can be recognized and measured or even developed through a careful manipulation of the preceding operations.

Gunite Corp. Produces Record Tonnage

Tonnage of castings produced in December by the Gunite Corp., Rockford, Ill., manufacturers of cast brake drums and general castings, established a new monthly record, according to a recent announcement by E. J. Mohr, manager. The company has the largest working force since starting in business four years ago and the plant is running full time.

Pacific Group Hears Talk on Japan

First hand information on the Manchurian situation, which is of considerable interest to industry on the Pacific slope, featured the monthly meeting of the Washington Foundrymen's club which was held Dec. 8 at the Exeter hotel, Seattle. The subject was presented by a local man, A. E. Holden, secretary of the Japan society, Seattle, who recently returned from a 5000-mile trip through Japan, China and Manchuria.

Mr. Holden stated that there would be no war between China and Japan over Manchuria, nor would there be an intervention on the part of the Powers. Japan, he stated, desired to maintain peaceful relations with China and her military activities in Manchuria were only necessary police precautions to protect Japan's investments and to maintain peace and order in a land overrun by bandits.

Until recent times, the Pacific Ocean has been a barrier separating the East from the West, but Mr. Holden believes that today the situation has changed, and with the annihilation of distance and time, the Far East has been changed to the Near West. Yet, the fact remains that the people of the United States know relatively little about the Orient. The speaker pointed out how easy it is for the Japanese to obtain a false impression of America through reading of such characters as control gangland in our large cities, and likewise, how many Americans have not had Japan adequately interpreted to them. The speaker drew a word picture of present day Japan, a picture of modern progress quite the opposite of the mystic East referred to so frequently in our literature. He told of Yokohama, a city as large as San Francisco, with modern hotels and department stores, and of baby golf courses and musical reviews in Tokio.

He emphasized that this modernistic aspect does not mean Japan is losing the historic culture which has made her a great nation. Japan first adopted western ideas, and then adapted them to Japanese conditions, and today Japan is becoming adept. He stressed four characteristics of the Japanese, namely: Loyalty, hospitality, fortitude and reverence.

Following Mr. Holden's lecture, general business conditions and foundry problems were discussed. Rex L. Alexander, president, Olympic Steel works, Seattle, and president of the Washington Foundrymen's club, presided at the meeting.

The American Refractories institute, Pittsburgh, has published a bulletin entitled "Sieve Analysis for Refractory Materials," by R. F. Ferguson, which gives informaton on methods of conductng the analysis, comparison of standard sieves, etc.

Make Early Steel History In Milwaukee

By Charles Vickers

Charles Vickers

ACCORDING to some authorities the pouring temperature of mild carbon steel for thin sections is around 1580-1640 degrees Cent. (2876-2984 degrees Fahr.). For sections, over 2 inches in thickness the temperature should be about 1500-1550 degrees Cent. (2732-2822 degrees Fahr.). To get these temperatures in a coke fired shaft furnace is not at all easy, and the writer is afraid that had it not been for his Hungarian mentor, a lot of time would have been wasted learning how to do it.

Soft Scrap Necessary

The furnace was an ordinary round boiler iron shell lined with fire brick, and connected with a brick flue to the foot of the stack. When we first started melting steel, Sol had the idea that it would be possible to melt high carbon steel, old files, hammers, chisels, and like material, the melting point of which is lower than that of boiler punchings, and horseshoe nail scrap. We imagined that we could anneal and soften the castings so that they could be machined, but found later that if we wanted to make soft steel castings, we had to melt soft steel.

Our experiments with the hard steel taught us that our 26-inch diameter brass furnace was too shallow. We increased the depth from 27 to 36 inches. The only coke we could use successfully was Connellsville 72-hour coke, which should not be broken too small. Therefore, for a No. 60 steel melting crucible, a furnace diameter of 26 inches was just about right. The melting stock was horseshoe nail clippings of Swedish iron and boiler plate punchings.

In charging the furnace, we placed the crucible on a base 9 inches in height. This base, at first was built up simply of three pieces of firebrick on the grate bars. After the fire was started, the coke was allowed to burn down until there was a solid bed of fire level with the top of the base. The bricks were then cleaned of all bits of coke and the charged crucible was put in and adjusted centrally and coked around the sides. When this coke was heated to a cherry red it was packed down to fill all burned out spaces. The furnace was filled with coke and the crucible was buried to a depth of 4 or 5 inches.

To prevent coke from getting inside the crucible with the steel, a cover was luted on the filled crucible while it was still cold. For a cover we preferred a bottom chopped off an old crucible, because we could make it deeper than the regular crucible covers obtained from the crucible makers. The cold charge was piled up to get the maximum amount in the crucible, from 60 to 100 pounds. A 2-inch hole punched through the cover centrally, was covered with a half fire brick while melting was going on.

When the furnace was filled with coke, the cast iron cover was rolled into place and sealed with damp molding sand, to prevent all air leakage. At the end of a 45-minute period the coke on top of the crucible cover was a bright red, while around the sides it had attained a white heat. The red hot coke on top of the crucible was now poked down to fill the vacancies around the sides where the coke had burned away. Fresh coke was thrown on top. The furnace was covered and resealed and left for another 45 minutes. This operation was repeated at the proper intervals for 5 hours when the metal was sufficiently hot to be removed and poured into the molds.

Poking the coke was the most important part of the whole process A little laziness on the part of the melter made all the difference between success and failure. No half measures were good enough. A man could not stand 2 or 3 feet away, and jab at the coke. The punching bar had to be held perpendicular. The operator had to stand over the fire, and consequently could only move the cover sufficiently to get the bar into the furnace. The heat was unbearable.

The bar had to be driven through the fire to hit the grate bars at every stroke. The hot coke had to be packed down to fill all vacancies particularly around the base. Otherwise a slag bridge would form extending from the sides of the furnace to the top of the base. The fire underneath would die, resulting in chilling the bottom of the crucible. The steel would be molten on top and solid in the bottom of the crucible.

Another cause of failure was the condition of the furnace. As might be expected, the intense heat rapidly cut away the lining. When this became ragged, slag covered, and barrel-shaped it was utterly impossible to take out a heat. The furnace would scaffold every time. Which means that a solid clinker would form from the walls to the top of the crucible base. The clinker was so hard and tenacious that it was difficult to break through it with a heavy steel bar and sledge. Even if it was broken through after much exhausting labor, it formed again before the metal had a chance to melt.

Was Solid at Bottom

The writer has known instances where furnaces in this condition devoured coke for 6 or 7 hours. An intense heat was produced on top, but the contents of the crucible were as solid as when put in. The only remedy was a new lining. To do good work the furnace had to be kept in good order.

Another trouble in melting was caused by the base. The common fire brick melted even when of the best grade. The pot fell over and was broken by its own weight pressing against the sides of the furnace.

We tried many materials for the bases. Crucibles were chopped off at the required height, filled inside with refractory material and baked. They lasted a short time—two heats—but melted and then solidified on the bottom of the crucible. The resulting flare made it almost impossible to get the pot of steel out of the furnace.

Hard To Lift

In pulling pots it was customary to use the entire shop crew—all three. One man steadied the tongs while two men lifted the pot with a long bar attached to a hook which fitted under the middle of the tongs. Naturally when the base came with the pot, the lift was at least 9 inches higher, and great exertion was required to clear the top of the furnace.

The third man, usually the foreman, had to hold the tongs and steer the pot. The pot was white hot, and the holder had hard work keeping his person 12 inches away. Before the struggle began he had to don a suit of gunny sacking, which then was saturated with water from a hose. When a base stuck, the gunny sacking usually was in a blaze before the pot was landed safely in its shank.

Finally the inverted crucible unanimously was voted out, and to make a long story short, we discovered that the best base was old brick taken from the worn out lining of a blast furnace. Happily we found these within convenient wheelbarrow distance of where we were struggling with this problem. Everything has to have a beginning, and some of the things pertaining to the beginnings of whole industries are things to laugh about—afterward.

The Illinois Steel Co. furnished us with our crucible bases, from their discard piles. The writer was especially thankful. Owing to shortness of stature, he found no joke in stretching upward on tiptoe, to hold to the tongs when a pot of steel came out of the furnace with a base affectionately sticking to it.

Detaching this base was a hard job demanding rapid action, before the molasses-like slag had set. Molten steel of low carbon content, waits for no man. In its normal condition it is a cold rather supercilious solid, and it reverts to that familiar state just as quickly as possible. It is a grim, earnest business, characterized by speed, when operating with crucibles. We powdered the top of the base with fine coke dust to discourage all attempts of crucible and base fraternizing.

Even then, all was not plain sailing. We tried to do without a base. A bed of coke was placed in the bottom of the furnace to bring the top of the crucible level with the mouth of the furnace. Coke was placed around the sides and on top as usual. It was poked down as required and more coke filled on top of the crucible, but all in vain. The coke under the crucible could not be replenished, with the result that the crucible reached the grate bars before the punchings and horseshoe nail scrap had more than welded together. If the pot was raised and recoked as is customary with brass, the contents would become a dull red before the fire picked up temperature and the entire operation would begin again.

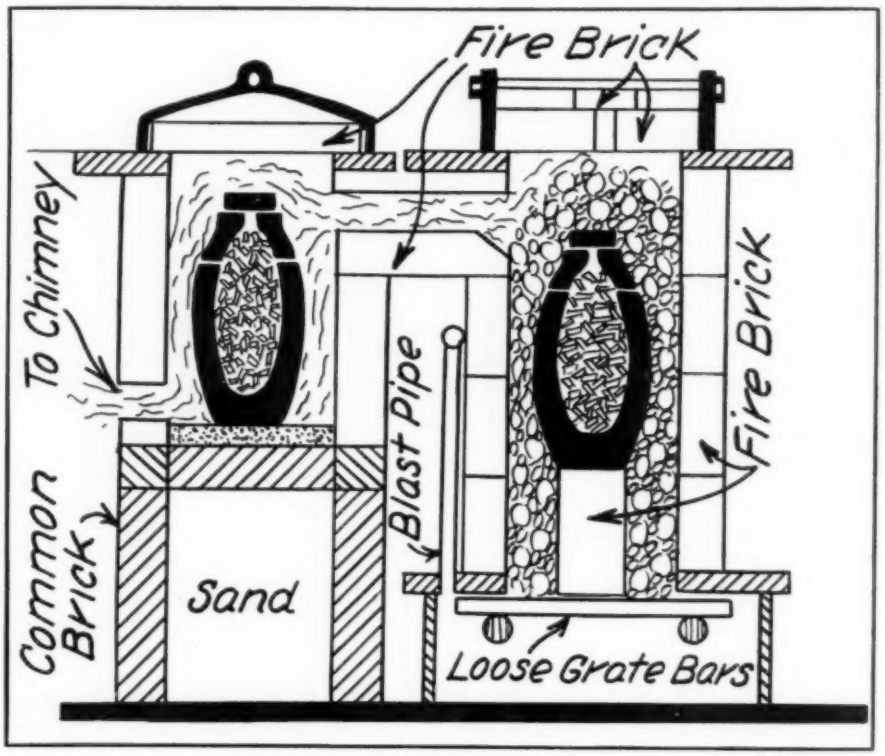


Fig. 3—Tandem, Coke-fired Steel Melting Furnace Using a Forced Draft

In presenting this history it is hoped the information concerning the method of melting refractory metals in a coke hole will be useful to some readers. The method is passe as far as steel is concerned, but it is history; history of the days when the modern, oil-fired, burner-equipped crucible furnace was unknown. Also in working experimentally with highly refractory metals, coke holes are useful to demonstrate cheaply the feasibility of an idea before the installation of more expensive furnaces.

Recharging the pot with punchings when it was thought the steel was hot, and this could be gaged quite closely, was not possible. This would chill the contents to the point where probably it never could be remelted. About 5 hours were required to bring out a heat, starting cold, and about 3½ hours starting with a hot furnace.

The sealing sand around the cover of the furnace was brushed away, so it would not fall into the fire to cause slag of which there was always more than sufficient. The cover itself was rolled off partially, then the top of the crucible cover was poked clear of bits of coke, and the brick covering the hole in the crucible was removed sidewise. A long thin bar ¼-inch diameter was passed into the crucible and if the end came out slag coated and sparkling, the steel was ready for the densening mixture.

For a long time we had trouble with the steel mushrooming out of the sprues although the densening mixture always was added with a good deal of ceremony prior to pulling the pots. A 2-inch length of gas pipe was inserted through the hole in the crucible cover. A funnel was attached to the outer end and the mixture in small nuggets was slid down the pipe into the crucible. It was not considered feasible to attempt to stir the steel, so it was allowed to remain in the furnace 5 minutes for the mixture to diffuse throughout the liquid mass. The method did not work as it should, for invariably the steel in the castings was not sound.

Secrecy Was Watchword

Addition of the densening mixture at Shaw's was attended with the same secrecy as it was at Dutchers'. It was a sacred rite, but as failure followed failure, the secrecy was lifted somewhat. A free expression of opinion indicated that insufficient mixture was being used. In due time, a change was instituted and from that time forward, little trouble occurred from spongy castings.

A typical charge for a medium mixture was: Return gates and scrap 40 pounds; boiler punchings

60 pounds. This was melted in a covered crucible and 5 minutes before removal from the fire 8 ounces of ferrosilicon and 8 ounces of ferromanganese were added. For a harder mixture we might use 60 pounds of gates and other return scrap, 40 pounds of punchings; 8 ounces of salt; 8 ounces of charcoal. When this metal was ready, we added 8 ounces of spiegel and 4 ounces of ferroaluminum. Many more mixtures were used but these will serve as examples. In soft steel, the fracture we liked best had a bright and finely granular surface. The harder metals would show fine crystalline and diamond-like surfaces.

We were now ready to start production. The first good steel casting we made was a lever of some sort. The customer was there to carry away the casting himself. It was quite an event. As the writer personally had made that casting, he insisted on going through the ceremony of selling it to the customer, handing over the casting with one hand and receiving the cash in the other. The assembled multitude applauded heartily, for each one of the three or four had done his bit in producing that casting.

Melt Two Heats Per Day

The original intention had been to install more coke holes as the business warranted, but experience with the first showed that it would be impossible to get operators. It wasn't in human nature for one man to operate a battery melting steel. Also they were too slow. Half a day was required to melt the first pot, and 6 hours for the two following heats, which made an 11-hour day. This meant continual overtime. It was not practical for regular operation. We found that two heats per day from one furnace were all we could expect, and then only if we did not lose a pot.

Sometimes the furnace, a simple, natural draft type, appeared to catch a lazy streak. It was very susceptible to atmospheric conditions, direction of the wind, humidity and so forth. What to do, became a problem until Sol read an article by a noted foundry writer of that period, in which he described a gas furnace adapted to melting steel.

An order was placed for one of the furnaces, and in due time it arrived on the scene with pressure blower and all equipment. It was installed according to directions which were full and complete, and included digging up the nice lawn to lay a 2 or 3-inch pipe extending from the street mains down to the furnace in the shop, a distance of 200 feet. Finally everything was complete and the furnace was started with a pot of steel inside.

It was a circular furnace, and I think had more than one burner introduced into the top on a tangent to the circumference, and so adjusted that the flame would strike the cover of the crucible and wind around to the bottom to depart by ports at that point, enveloping both crucible and crucible support in its passage through the furnace. It was just the opposite of the modern crucible furnace, in which the flame enters at the bottom and emerges at the top through a hole in the furnace cover.

The performance of this furnace was a great disappointment. It never melted steel, nor came near it, but that might have been the fault of the gas, which was artificial. Without blast, the burner ran through 7 feet of gas per minute. With the blast, this was reduced first to 5 cubic feet per minute, and finally to 3 feet per minute as the furnace became hot. The pressure of the blast was 16 ounces, and we calculated that the blower absorbed 3 horsepower for the one furnace.

After running 2½ hours the furnace had only attained a bright red heat and it seemed to have reached its maximum temperature. It was, therefore, considered an expensive failure, and we ever afterward wondered what kind of *steel* the author of the paper had melted.

According to a paper presented by Leo L. Dana before the American Institute of Mining & Metallurgical Engineers, Chicago, September, 1919, a furnace fired with illuminating gas made from coal and using air at 2 or 3 pounds pressure, will attain a maximum temperature of 1400 degrees Cent; (2552 degrees Fahr.) in an ordinary furnace. Using natural gas in the same furnace, with the same air pressure, a temperature from 1500 to 1600 degrees Cent., (2732 to 2912 degrees Fahr.) may be attained. With a blower giving only one pound air pressure therefore, our furnace was a failure before it started. If Dana's figures had been available, we could have saved a lot of money.

Change to Oil Fuel

We then tried oil in the same furnace. The burners were supplied with air at 16 ounces which issued through a circular hole in the center of the burner. The oil was fed by gravity through an annular opening surrounding the air port. In those days, some 40 years ago, much less was known about burner construction than at present. A dozen burners now are available quite competent to melt steel, nickel, or other high melting point metals.

Our experiment with oil turned out a little better than with the gas, but we could not approach the melting point of steel. The question may be asked, why did we not install the Nobel furnace, the same successful furnace that Dutchers used. The answer is, it was a question of capital. We did come to them later when a company was formed. It was a family affair no longer, and the inevitable happened.

We went back to the coke-fired furnace as shown in cross section in Fig. 3. We no longer were dependent upon the vagaries of the weather. We used the pressure blower bought for the gas furnace. The blower was driven by a small steam engine and supplied air at 16 ounces under the ashpit of the furnace. Another innovation was a preheating chamber, an idea taken from the Nobel furnace. This preheating chamber was built in the flue, enlarged to form a heating chamber.

The furnace would accommodate only two pots; one in the coke shaft and another in the flue. The results obtained in some respects were remarkable in those days. Starting with a cold furnace a 100-pound charge of wrought iron was melted hot enough to pour in 3½ hours. The Nobel furnace required from 4½ to 7 hours for the first heat. After the first pot was drawn from the coke furnace it was replaced by the hot one from the flue, and the second pot in turn was replaced by a cold pot. The second pot was ready in 1¾ hours. The corresponding time for the oil furnace was 1½ hours. The furnace decidedly was more efficient than the former simple coke hole.

Constant Attention Required

At first the chamber in the flue did not save as much heat as we had anticipated. The products of combustion from the first chamber failed to burn freely. We mainly recovered a portion of the heat of the hot gases. The carbon monoxide passed up the chimney. We turned part of the blast into the flue, and burned the combustible gases there by utilizing the atom of carbon that had been lost from the reserve fuel on top of the crucible in the melting hole. This was a great improvement. To obtain good results consistently with this type of furnace the lining had to be kept in good condition; the fuel had to be poked down often and thoroughly, and the pressure of the blast had to be kept constant.

Growth of business made another furnace necessary. One day the writer drove the old horse and buggy down to Nordbergs, maker of corliss engines and engine governors. Superintendent Schulke was shown what we could do in cast steel, sprue heads drawn out into rapiers, knives and so forth.

His response was immediate. He called for the boss patternmaker. I drove back with a buggy load of nice yellow gear patterns, and other patterns and core boxes. If my memory serves me right we turned out the castings with credit. Everyone was pleased and the air was filled with the optimistic talk usual on

like occasions. But alas, and many other alases; some folks say life is funny, when tragedy would be the better word.

We built a second furnace but instead of getting a pressure blower to run the two, someone suggested the purchase of a low pressure blower or fan. A number of folks around there knew many things that were not so. We started to supply the furnaces with a large volume of air at a low pressure, and that was the beginning of more troubles. The fire burned all right on top, but the bottom of the furnace was dead and the bottom of the crucible could not be heated, and under such conditions no one could melt steel. We pulled the pots, cleaned out the furnaces, and recharged them, this time with hard coal.

Gas Raises Havoc

The two furnaces were started one June day with this fuel. In a little while they both became voluminous carbon monoxide producers, dense fumes coming from underneath the furnace covers. That was one great day. Although all windows were open to their fullest extent, every one of the little force was dragged out and laid on the lawn in the shade where Mrs. Sol Shaw, a competent lady, administered to them so they were able to go home, but they did not return for several days. The furnaces were shut down and left to cool and that experience never was repeated.

One cannot but admire the stubborn perseverance of Sol Shaw. He gave of his substance freely. Never a rich man, all the losses outlined were a severe drain on his resources. He was compelled to seek outside capital, and then the little shop was enlarged, thus destroying the lawn and the beauties of his home. Two Nobel furnaces were built and a large ugly steel stack put up. When one furnace was working, the other usually was shut down for repairs to the bridge walls. They had to be partially rebuilt every three days. Crucibles were costly; over half a cent per pound of steel for crucibles, even when bought by the carload. Their maximum life was 3 heats, the average life 2½ heats. The writer recalls instances where, out of a whole car load of pots not one withstood three heats. This refers to pots holding only 100 pounds of steel. With crucibles holding 200 pounds, not one instance was known, in the experience of two different firms, where more than two heats had been taken from any one crucible.

The trouble with the Nobel furnace was due to the flame traveling at a high velocity; like a stream of running water this flame washed away the crucibles. After the first heat the sides of the crucibles in the direction of flame travel were worn thin, and it was necessary to turn the other side toward the flame on the second heat. In the coke-fired furnaces the crucibles usually enured eight heats despite the friction of the coke during the punching process. In the regenerative crucible furnace, the average life of a crucible was four heats. Some lasted as high as seven heats while others only lasted two. Usually this type of furnace was used more for making ingot steel.

Shaw's success in making soft steel castings stimulated others. In

The Likeness of Coach Stagg Reproduced in Metal

a few years numerous crucible steel foundries appeared in Milwaukee Then came competition and gone were the days when anyone could load his buggy with patterns.

Dutchers went out of business, probably finding it too competitive. Lang who had been their foreman for years, left and started his own steel foundry. Later he abandoned crucibles for the electric furnace. Smiths opened up the old Filer & Stowel foundry on Clinton street, and started casting steel; at first from the Nobel furnaces.

Try Open-hearth Furnace

During their early days one experiment that failed to turn out well was an open-hearth furnace, on the principle of the Nobel furnace. The capacity, as I recollect was about one ton of steel, but it might have been more. It was fired by two sets of pan burners placed side by side, and was erected by Schwartz, the inventor of the tea kettle brass melting furnace.

The furnace melted steel at a terrific consumption of oil, but it was not liquid enough to flow from the furnace. After it cooled the furnace was torn down, and the mass of steel was buried in the foundry floor, where it is yet for all the writer knows to the contrary. Sol Shaw sowed, but others reaped. So far as the writer is aware, his name never has been connected with the beginning of the steel industry. He lost everything, in spite of his persevering labors. The last time the writer saw him, he was located in Chicago as superintendent of the Chalmers Co. iron foundry and filled with enthusiasm over some novel way of mixing cast iron. Long ago he passed to his well earned rest.

This is the second of two articles by Mr. Vickers on the early history of the steel industry in Milwaukee. The first article appeared in the Jan. 1 issue.

THE EDITORS.

Cast Book Ends Honor Coach Stagg

The Western Foundry Co., Kedzie avenue at 36th street, Chicago, recently conceived the idea of honoring Alonzo A. Stagg, on his fortieth anniversary as football coach at the University of Chicago with souvenir book ends bearing a striking likeness of the coach, a ribbon inscription at the base "The Grand Old Man," and a miniature football suggesting the association. A photograph of one book end is reproduced in the accompanying illustration.

The item was originated by the foundry with the idea of offering a period of employment to a few men. Each pair is finished in bronze or brass, and bears a sticker stating that all receipts from the sale of the souvenirs are to be given to the governor's commission for unemployment and relief. The book ends may be obtained from several of the leading stores located in the Chicago loop district, or from the Western Foundry company.

The "Grand Old Man" book end idea was carried out by Dan A. Cullinan, treasurer of the Western Foundry Co. and himself an ardent football fan.

Reports on Accidents

Reports from 111 of the 180 foundries enrolled in the safety campaign sponsored by the Ohio Foundries association, show that 11,173 employes worked 997,462 man hours during November with 39 minor accidents, according to Robert Hoierman, managing director of the campaign. This record averages a foundry accident for each 25,576 man hours.

Of the 39 accidents, 15 resulted in 1 to 7 days lost time each while 24 resulted in more than 7 days lost time each. No permanent impairments and no permanent total disability mishaps were recorded.

The campaign has entered the third month in an effort to reduce the frequency and severity of accidents and to study mishap records as a step towards securing a lower state insurance rate.

Sea Coal Affects Permeability Of Molding Sands

By Walter M. Saunders Sr. and Walter M. Saunders Jr.

ON HEATING molding sands containing moisture, the permeability decreases, irrespective of the class of sand or the location from which it comes. At a fairly low temperature, around 200 degrees Cent., the permeability is low. Around 300 degrees Cent. it increases, before falling off gradually to a low figure at 1000 degrees Cent. This break in the curve has been explained by the liberation of steam from the moist sand and by a small amount of gas from the decomposition of the organic matter in the sand.

Two Sands Examined

It is the purpose of this article to describe the effect of a facing mixture containing sea coal on the curves of permeability versus temperature of heating. In addition, it was decided during the experimental work to obtain these curves using core sand with binders.

Two molding sands were chosen for use with sea coal. These sands are called *coarse* and *fine*, and are described as follows:

Sand	Name	Grain fineness	Clay substance per cent	Loss on ignition per cent
Coarse	Millville gravel	45	15.56	2.41
Fine	Albany	98	10.80	1.60

Confirm Theory

THE theory often has been advanced that the gas evolved from sea coal in facings for gray iron castings acts as a cushion for the metal against the mold and prevents the metal from sticking to the sand. The investigations of the authors, who are foundry consultants, Providence, R. I., tend to confirm that theory and also to explain the mechanism involved. This article, which is abstracted from a paper presented at the Chicago convention of the American Foundrymen's association, also shows the effect of sea coal on core mixtures used in the foundry.

Sea coal had the following analysis:

Moisture, per cent	Volatile matter, per cent	Ash, per cent	Fixed-carbon per cent
0.82	32.37	9.78	57.03

Using a modified type of American Foundrymen's association standard ramming apparatus, cores of sand, containing 6, 8, 10, 12 and 14 per cent by weight of sea coal, were made. In all cases the moisture content of these cores of molding sand was held at 6 per cent. It is realized that a fine sand like the Albany sand is not used commonly in mixtures of sea coal for facing. However, extreme cases were desired in these experiments.

In addition, cores were made of core-sand mixtures actually used in the foundry. Out of several sands tested, three were selected. The proportions of a commercial oil binder and core sand were 1 to 60, 1 to 55, and 1 to 45. The cores were baked in the tube at 200 degrees Cent., (392 degrees Fahr.), for 15 minutes, before use in the permeability tests.

Properties of the core sands used were as follows:

Mixture	Grain fineness	Loss on ignition, per cent
1-60	63	2.26
1-55	122	2.13
1-45	180	2.36

During the heating of the test cores, permeability readings were obtained at each 50 degrees Cent. (122 degrees Fahr.) interval up to 1000 degrees Cent. (1832 degrees Fahr.). In like manner on cooling from 1000 degrees Fahr., the permeability

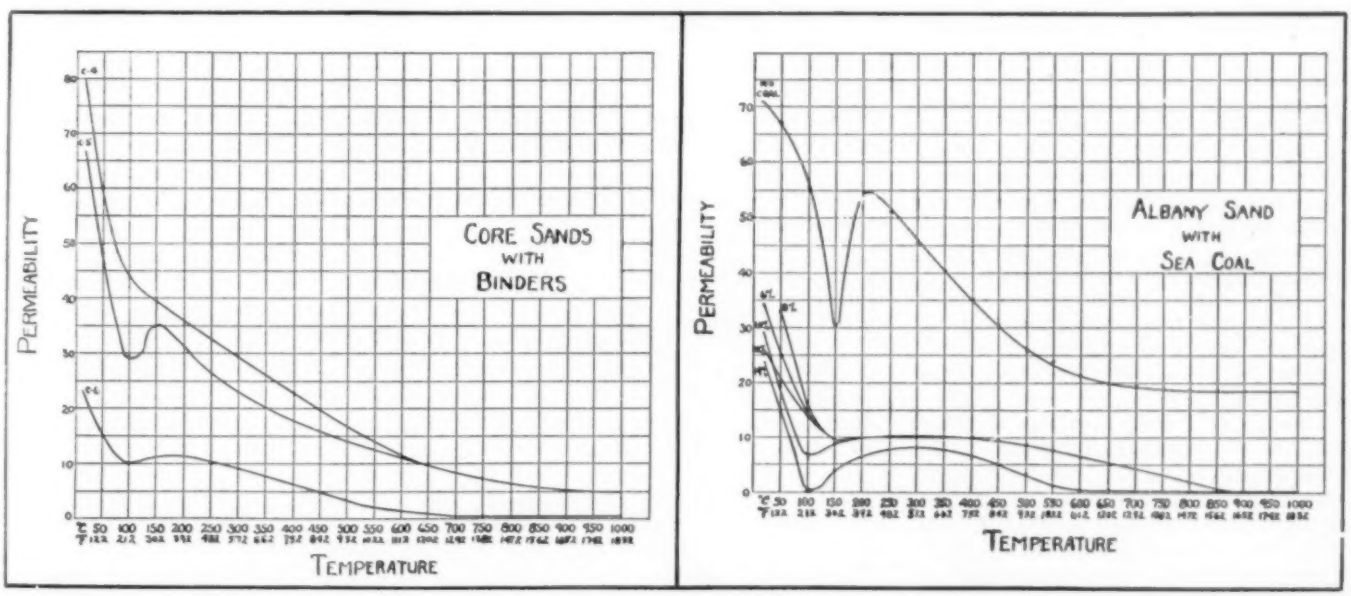


Fig. 1—Curves Showing the Effect of Sea Coal on the Permeability of Core Sand Mixtures. Fig. 2—Curves Showing Effect of Addition of Various Percentages of Sea Coal on Albany Sand

was determined. Determinations were made at the loss on ignition of the dry mixtures of molding sand and sea coal, before the test cores were rammed. At the end of each run, the volatile combustible matter left in the sand was determined, using the same method as that for coal.

Permeability readings as ordinates, and the temperature as abscissas for heating the cores, are shown in Figs. 1, 2 and 3. The heating curves for both molding sands without sea coal also are shown. Results of the determinations of loss on ignition of the dried molding sands containing sea coal, are summarized in Table I. Volatile combustible matter left in the molding sands on heating to 1000 degrees Cent., 1832 degrees Fahr., and cooling to room temperature is shown in Table II. The break in the curve, where permeability is plotted against temperature, around 200 degrees Cent., is at a slightly lower temperature for molding sands containing sea coal than for natural molding sands. It is believed that this is due to the gas from the sea coal starting to come off earlier. Under the conditions of the test, the volatile matter from the coal was distilled off practically in the absence of air. This volatile matter caused considerable back pressure, and in some cases blew the liquid out of the manometer of the permeability apparatus.

Sea coal exerted a striking effect on the permeability of the sand at room temperature. Even after the volatile matter had been removed by heating, the effect was still noted. The test cores of core-sand mixtures follow the same general curves as previously mentioned. No break in the curve was expected at 200 to 300 degrees Cent. 392 to 572 degrees Fahr. The cores were supposedly dry, since they had been heated to 200 degrees Cent., 392 degrees Fahr., for 15 minutes before use.

A break in the curve suggests that some moisture was present. It is believed that this moisture was taken up by the core-sand mixture, after they were dried, and then cooled to room temperature. The volatile matter left in the sand after heating to 1000 degrees Cent. shows that practically all of the volatile gases have been distilled out of the coal.

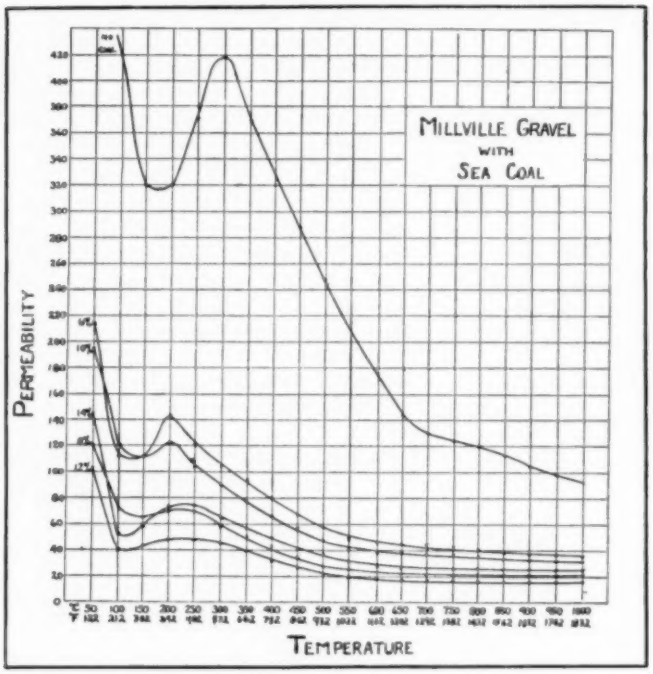


Fig. 3 — Curves Showing the Effect of Various Additions of Sea Coal on Molding Sand Known as Millville Gravel

Theory Is Confirmed

It is believed that the results of these tests confirm the theory which has been advanced regarding the action of sea coal in facing sands. Various statements have been made that gas from sea coal acted as a cushion between mold and metal.

From the permeability readings obtained on heating sea-coal facing sands, it is believed additional light is thrown on what happens when iron is poured into molds faced with sea coal. First, the hot metal dries out a thin skin of molding sand. The moisture, which is turned into steam, passes trough the sand and out of the mold. After this moisture is expelled, the sand, becoming hotter, decreases markedly in permeability, due to the expansion of the grains of sand. At the same time, the volatile matter starts to distill from the sea coal, and the coal, around the grains of sand swells.

This swelling of the coal and expansion of the grains of sand decreases the permeability of the sea-coal sand mixtures to a low figure and the volatile matter from the coal can pass out only along the face of the mold. Meeting the molten metal filling the mold, the gas must act as a cushion or film between the sand and metal. That there is a decomposition of the carbon-rich gases of the volatile matter, to *smoke* the surface of the casting, or that a reducing action of these gases on the film of oxide covering the metal takes place, is not denied. The results obtained lead us to believe that a film of carbon-rich gas must be present between the molten iron and the face of the mold.

It is well known that the moisture content of molding sand must be kept within limits. Excessive moisture causes blow holes in the casting. In like manner, the amount of sea coal used in a facing sand must be such that a slow evolution of gas from the coal takes place. Too rapid an evolution would cause a rough surface.

From the results of the tests it will be seen that: (a) Additions of sea coal to natural molding sands result in a decided diminution of permeability at room temperature, the effect still being exerted on heating the sand after the volatile matter has been removed; (b) the volatile matter in sea coal, with the swelling of the coal, is responsible for the effectiveness of sea coal in producing a smooth surface on a casting; (c) mixtures of molding sand and sea coal used as facing sands may vary considerably in proportions, without changing the behavior of a given sand under heat; and (d) core sands with binders, like natural molding sands, have progressively lower permeability when heated.

Table I

Loss on Ignition of Dried Molding Sands

Sea coal, per cent	6	8	10	12	14
Course, per cent	9.06	11.53	12.24	14.05	15.80
Fine, per cent	7.13	8.88	10.48	12.25	13.81

Table II

Volatile Matter Left in Molding Sands

(Heated to 1000 Degs. Cent.)

Sea coal, per cent	6	8	10	12	14
Course, per cent	0.79	0.83	0.92	0.87	0.90
Fine, per cent	0.67	0.77	0.65	0.55	0.74

Prevent Losses With Proper Gates and Risers

By Pat Dwyer

BASIC principles underlying the application of gates and risers are the same for either ferrous or nonferrous metals. Many of the individual features covered in preceding articles in this series dealing with gray iron foundry practice, might just as appropriately have been written from the nonferrous foundryman's point of view. For the foregoing reasons the section of the series to be devoted to nonferrous gates and risers will not be as extensive as the section just completed on gray iron.

Consider Typical Castings

As nearly as possible the plan pursued in the first section will be followed in presenting this section, and later, other sections dealing with aluminum, steel and malleable iron. That is, typical castings will be considered in alphabetical order. As pointed out previously the alphabetical order cannot be followed strictly, because many castings similar in many features so far as molding, gating and pouring are concerned, differ widely in the names by which they are known. For example, rings, bushings, sleeves, liners, ferrules, thimbles and pipes share nearly all features in common with the exception of the names.

With the foregoing method of classification in mind, the subject of gates in relation to nonferrous castings will be considered under the following heads: Bearings, bells, bushings, copper castings, flanges, liners, miscellaneous, patterns, pressure castings, plungers, propellers, pump, rings, statuary, sticks, tablets, wheels.

Bronze bearings are made according to an almost endless variety of sizes and designs. In the majority of instances no special gates are required. Any one of several styles regarded as standard may be employed with perfect safety. For example, freight car bearings ranging in weight from 10 to 40 pounds are molded in a flask, face down, and poured through a single sprue near one end of the flask at the center. The sprue is connected to the end of each mold cavity by a single small, plain gate.

With some patterns it is advisable to ram a small chill block against the face of the pattern to insure density of metal in that section. With others it may be necessary to use a high pouring head to prevent shrinkage.

On large bearings—or other castings molded in such a manner that a projecting body of sand halts the flow of metal from one part of the mold to another part—two or more gates should be provided so that none of the metal has to rise over a hill and then run down into the valley on the other side. A gate leading into each valley will cause the mold to fill uniformly.

Under the first set of conditions the level of the metal in the first valley will remain stationary while the stream is flowing over the top of the mound of sand in the center. This temporary halt will be reflected in a cold-shut streak on the side of the surface of the casting. In some instances a sufficient film will form on top of the halted metal to separate part of the casting into two layers. In addition to this possible and probable form of defect, the thin streams of metal flowing over the sand mound is not heavy enough to prevent the upward flow of gas and steam. The result is a rough and scabby face on the casting and a honeycomb structure in the metal. The foregoing features are shown graphically in the conventional illustration of a bearing, Fig. 130.

Gating Brass

GATING problems of the brass foundry will be considered in this and several succeeding issues. Permanent molds do not offer a solution for all the ills of the brass foundry, but under certain conditions their substitution for sand molds seems to offer economic advantage. On account of the chilling effect, the brass or bronze must be poured into these molds at a higher temperature than where a similar metal is poured into sand molds. Larger gates are required for the purpose of admitting the metal rapidly and in larger volume in the early stages of filling the mold. Later the large gate acts as a feeder into which the metal is poured in a steadily dwindling stream. Massive construction of the molds is advocated so that the heat from the casting may be absorbed without raising the temperature of the mass above 850 degrees Fahr.

Bearings Molded on End

Some bearings, for example locomotive driving brasses varying in weight from 145 to 360 pounds and with a maximum thickness of 3½ inches, as shown in Fig. 131, may be molded on end. This greatly simplifies the molding practice and automatically removes the hazards indicated in the preceding paragraph. However, the method introduces other hazards which must be taken into account. One disadvantage of this method is that the face of the mold cannot be covered with plumbago or other refractory facing unless the molder goes to the extraordinary bother of parting the mold top and bottom. In a hypothetical case of that kind he could lift the outside away on a cheek, or, the inside away on a lifting plate or drawback.

The usual mixture for these castings is an alloy composed of copper, 75-80 per cent; tin, 8-10 per cent; lead, 10-14 per cent, and zinc maximum 3 per cent. If this metal is poured at a temperature of 2100 degrees Fahr. the casting is solid, but the surface is exceedingly rough. If poured at a lower temperature—around 1800 degrees—the face of the casting is fairly smooth and clean, but a shrinkage or porous area appears on the upper, inside face as shown in Fig. 131. Two methods are available for the prevention of this form of defect known as a *copper spot*. In the first, the mold is prepared in a manner to resist the high temperature metal. In the second a riser or feeder is provided on top of the casting.

Since the underlying cause of this form of defect is bound to crop up in a discussion of almost all types of nonferrous castings, it may be advisable to digress briefly at this time and consider the phenomenon incident to

metal passing from the liquid to the solid state. The porous spot in the casting shown in Fig. 131 is caused by the natural shrinkage of the metal. The upper part of the casting feeds the lower part with eutectic which seeps downward between the crystals of solidified metal. The metal remain liquid longest at the top center. The eutectic is that portion of the al-

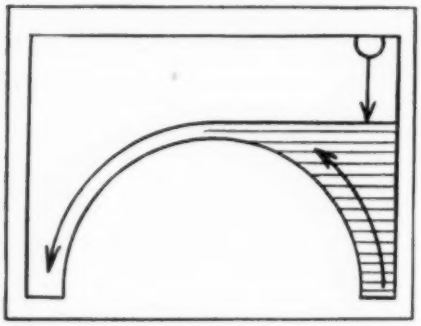


Fig. 130—Metal Falling From a Single Gate Has To Climb a Hill To Fill the Other Side

loy which remains liquid longer than the other component parts of the mixture, because it is richer in tin. In obedience to a natural law, it drains into the lower voids leaving crystals of the faster freezing compounds in the space formerly occupied by the eutectic.

Skin Dulls the Tools

Where the metal is poured extremely hot, the loss is compensated by absorption of fresh metal from the gates or risers. However, this hot metal, especially when phosphorized, will eat into the sand. Also in a high phosphorus metal, often specified in high-lead-high-tin bearing alloys, a phosphide migration takes place to the outer skin of the casting and displaces the lead. This hard phosphide skin will dull the machinist's tools rapidly.

Metal poured at 1850 degrees Fahr. cools so rapidly that the gate cannot act as a feeder. A large riser should be built up on the cope immediately above the area in the casting where the copper spot is anticipated. In a green sand mold it may be found advisable to form the riser in a dry sand core, either formed as a unit or built up in sections from the top of the pattern. Hot metal poured into the riser will feed the casting and compensate for the eutectic drained away.

Whichever process is adopted, certain precautions must be observed to secure satisfactory castings. The feeding factor is paramount where cool metal is employed. With hot metal it may be necessary to lower the phosphorus content, to use facing sand against the pattern and to apply a coating of plumbago to the face of the mold. In extreme instances true economy may be practiced by skin drying or completely drying the mold.

In this connection attention is directed to a feature covered in a preceding article in this series and dealing with various causes of shrinkage. It is as applicable to brass or bronze as it is to gray iron. A mold that is not sufficiently rigid to resist all internal pressure will yield to a greater or less extent when it is filled with metal. Metal is drawn from the top to fill the swollen area at or near the bottom. The shrunken area at the top of the casting usually is ascribed to unsatisfactory gates, risers, or the metal composition, when in reality none of these factors is to blame.

In some instances the sand is not rammed sufficiently hard to resist the pressure of the molten metal. In other instances the sand is rammed to the proper density, but the flask or container is not sufficiently rigid. Wood flasks particularly come under this category and frequently enjoy a greater confidence than they deserve. On snap flask work, loose fitting jackets are responsible for swollen, missmatched and distorted castings.

Urged partly by cost reducing motives, but principally by the universal desire of every foundry manager and every master mechanic to simplify every job as much as possible and to remove all possible stumbling blocks from the path of the workmen, several foundries have adopted iron or so-called permanent molds for the production of railroad bronze castings. Adoption of this method does not mean that the millenium has arrived, but published reports seem to indicate that the method presents many advantages.

Castings from these molds show a more uniform hardness throughout their mass than sand mold castings Slower solidification in sand molds causes the tin to form $Cu_2 Sn_2$ compounds at the core and $Cu_5 Sn_2$ combinations at the walls. This condition is aggravated by the liquation of tin in castings of high tin content in the presence of zinc and considerable lead.

Shows Typical Mold

In addition to producing better quality castings, chill molds automatically eliminate many of the hazards incident to sand molding practice. Arguments between the metallurgist, foreman and molder, on the sand and its preparation, facing materials, hard or soft ramming, scabbing, burning in, porosity from steam due to hard or wet molds, no longer appear on the daily program.

A simple duplex type permanent mold suitable for casting red brass machinery bushings with thin walls, or, solid round sticks is shown in Fig. 133. The mold is made up of three main parts, two sides and a bottom. The top of each mold ends in a conical shape forming the riser and this conical shape in turn ends in a cylindrical form in which the device *H* fits concentrically to hold the core in the center of the mold. The side pieces rest or slide on a bottom plate and are held in position by two steel clamps. A recessed boss on the bottom plate serves as a stop for the side pieces and a bottom print for the core. A plain bottom plate is substituted when the mold is set up for solid sticks.

Determine the Thickness

According to Henri Marius who carried on extensive investigation of this subject at the plant of the Lenoir Car Works, Lenoir City, Tenn., thickness of the mold walls should be based on the weight of the proposed casting and may be determined from the following empirical formula derived from practical experiment:

$$\frac{W\,(t-t^1)}{Pr.Rt} \times \frac{1}{H} = T \text{ in which}$$

W = Weight of bushing
t = Pouring temperature of the alloy from which the bushing is made
t^1 = Temperature of the bushing at the shaking out
Pr = Time in minutes the bushing is desired to remain in the mold before it reaches shaking out temperature
Rt = Maximum allowable increase in temperature of the mold after pouring
H = Height or length of the bushing

In permanent mold design the wall thickness is an important element. It

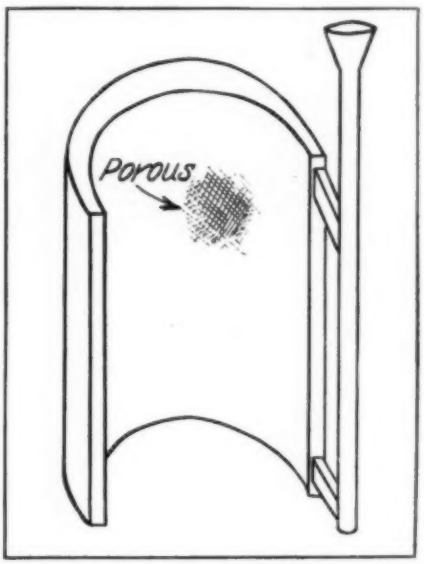


Fig. 131—A Porous Area Will Develop In A Heavy Bearing That Is Not Poured At the Proper Temperature

directly controls the pouring schedule. Massive molds permit a greater number of pourings in a given period. The danger of molds overheating to a point where they are difficult to handle, is eliminated. Mr. Marius' experiments indicated that the life of a mold is materially shortened when the temperature of the mass is raised above 850 degrees Fahr. Another advantage of massive walls is that after a period of service has developed fire cracks,

the mold may be rebored or refinished at little cost for castings of a larger size.

At the beginning of operation the mold is preheated with an oil torch to an approximate temperature of 250 degrees, Fahr. Then the face is sprayed or brushed with a mixture of paraffine lubricating oil and lampblack or graphite. This application serves a two fold purpose: The greasy material in this oil forms a thin protective coating on the face of the mold, similar to that derived from coal dust in a sand mold. Evaporation of volatile matter in the oil, cools the mold between filling periods.

Raise The Temperature

Heavy, coal tar base crude oils are not well suited for mold dressing. Pitch deposit on the face of the mold sticks to the face of the casting and the result is a black, dirty pitted surface. Kerosene oil would serve satisfactorily, but it is dangerous on account of the low flash point.

Pouring temperature with either sand or permanent molds varies ac cording to the copper content of the alloy. Owing to the chilling effect of the permanent mold, maximum fluidity of the molten metal is of paramount importance. The temperature of metal poured into permanent molds should be from 75 to 100 degrees higher than that for similar metal poured in sand molds.

Cold pouring will result in *red spot* or *copper spot*, cold shuts, wrinkles and draws under the riser and gates. A fracture will show the characteristic little round holes of occluded gas. Metal poured too hot will produce patches of honeycomb metal and greater shrinkage.

Although apparently simple, the problem of designing a proper gating system for a permanent mold requires a considerable background of practical and technical foundry knowledge. An improperly designed mold must be scrapped and that may involve considerable expense including the cost of materials, pattern and machine shop labor and other production expense items.

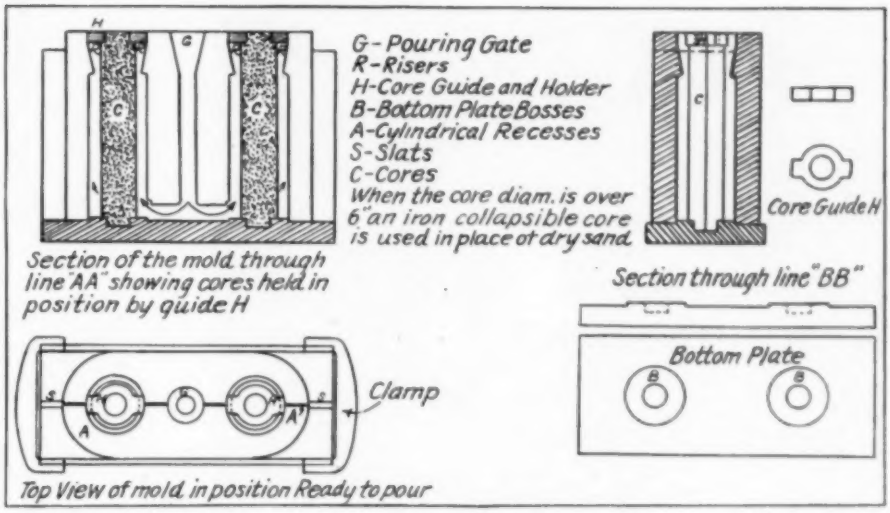

G-Pouring Gate
R-Risers
H-Core Guide and Holder
B-Bottom Plate Bosses
A-Cylindrical Recesses
S-Slats
C-Cores
When the core diam. is over 6" an iron collapsible core is used in place of dry sand
Core Guide H
Section of the mold through line "AA" showing cores held in position by guide H
Section through line "BB"
Bottom Plate
Clamp
Top View of mold in position Ready to pour

Fig. 133—A Suitable Recess in the Bottom Plate Centers the Core. Metal Enters the Mold at the Bottom and Flows Upward Rapidly at First and Then More Slowly

Bottom gates are recommended for permanent mold because the metal from a bottom gate rises in the mold evenly and gently. There is no splashing with a subsequent formation of cuprous oxide covered metal globules Gases from the mold coating may es cape more rapidly. Erosion of the mold wall due to rapid descent of metal, is avoided.

Wherever possible the gate and riser should be placed in a vertical plane that crosses the casting through the heaviest section and thus divides it as nearly as possible into two equal parts. With this arrangement the mold is filled uniformly and the metal reaches sharp corners and other points while still at maximum fluidity. The gate between the sprue and the casting should not be less than 1½ inches, for the obvious reason that 1½ inches is the minimum thickness of metal that may be tolerated between the sprue and the mold cavity. A thin wall at this point will become overheated and will be reflected in the face of the casting.

At the beginning of the operation, the metal is poured rapidly, but gradually the speed is reduced so that by the time the metal in the mold appears in the bottom of the riser, only a small stream is flowing from the ladle or crucible into the gate. This method provides a reservoir or hot metal for a maximum period and prevents piping and shrinkage cavities.

Gives Mold Life

Readers interested in or contemplating installation of permanent molds for brass and bronze castings may draw their own conclusions on the probable economics of the measure by noting a few additional features of the Lenoir City installation. The average life of the molds is stated to be from 1000 to 3000 castings, depending on size and weight. Castings with sharp corners and heavy flanges are harder on the molds than those of round or simple contour. Two hundred molds representing 160 different patterns are accommodated in a space 30 x 100 feet. A mold never is moved from

(*Concluded on Page 45*)

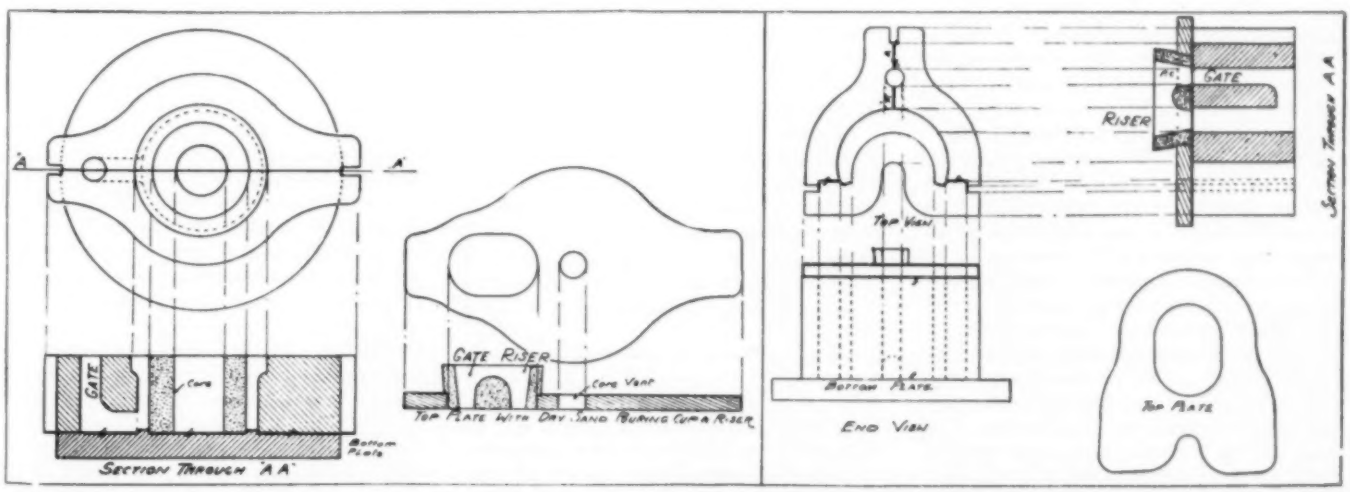
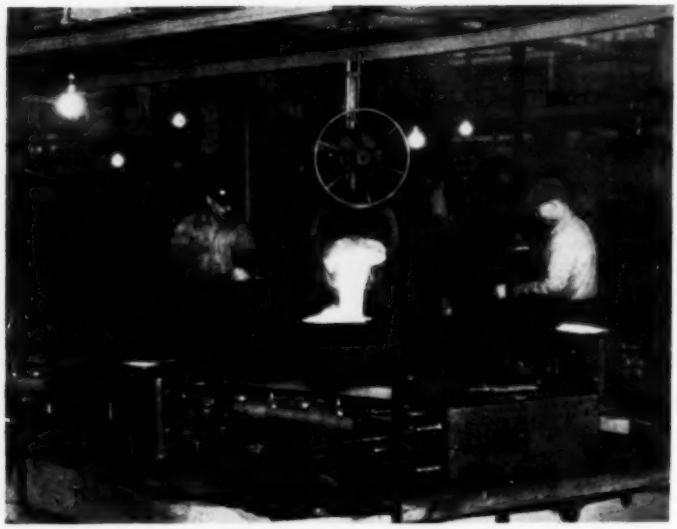


Fig. 132—(Left)—Cross Section of Mold for a Locomotive Floating Bushing and the Combination Iron and Dry Sand Pouring Basin. (Right)—Crown Bearing Mold Showing the Bottom Plate, Front and Back of the Mold and Top Plate



Many Safety Devices Are Available for Men Pouring Iron

Foremen *Cultivate* SAFETY Movement

By T. F. Jennings

THE safety first movement in this country based on Dr. William H. Tolman's studies of accident prevention abroad, was the first organized move against preventable deaths and injuries. No movement in centuries has done so much good in so short a time.

Thirty-one years battle against accidents materially has reduced the casualty rate, and what is more important, has caused such a thorough analysis of accidents that we are all becoming experts on dangers to be avoided.

Are Due to Carelessness

Safety first authorities claim that 80 per cent of accidents are due to carelessness. Few accidents occur in the dynamite industry. The workers know they are in the presence of death. They have demonstrated that personal caution is the most effective method of preventing accidents. A cautious person seldom is injured. Usually an accident is the result of some distracting circumstances or lack of concentration on the task immediately in hand. A cautious individual seldom will invite danger. He will avoid chances and cannot be tempted into recklessness. Involuntarily he visualizes the consequence of an accident before taking a risk. For this reason education is the most effective medium of developing habits of caution. Prevention of accidents never can become automatic. Safety devices help materially but human caution is the most powerful protection against accidents.

Experience has shown that one of the most effective ways for the prevention of accidents comes from a proper safety organization within the plant itself. This organization involves some form of safety committee system working to develop the best safety methods, not only in the field of mechanical safeguards but also in the education of the employes in the observance of proper precautions and the spirit of safety itself.

Only in recent years has the subject of industrial accidents attracted nation wide attention. With the advent of workman's compensation legislation, the relative frequency of industrial accidents in different occupations becomes at once a serious business concern.

Only a small percentage of accidents are not preventable by precautionary measures. Means of bringing about safety are unlimited. They are all good and have their effect, but the purpose of all is the same. To drive home to the individual the correct idea of safety. To enlist his co-operation. To teach him to think of the welfare of others as well as his own safety.

The end to which we are all working is accident prevention. To decrease the cost to the employers and to those contributing to the payment of workmen's compensation. A much greater benefit is derived from reducing the number of injured workmen. Whenever the earning power of a workman is diminished, the community and state suffer.

The workman is becoming educated to the point where he realizes that he is his brother's keeper and that he not only owes it to himself, but to his fellows to refrain from doing that which will place himself or his fellow workman in unnecessary danger.

Develop Personal Caution

Carelessness is the greatest enemy to safety. What is the remedy?

In our personal life or business projects, safety always has revolved around caution. Caution also is the only safe-guard which has proved effective in reducing the number or the severity of accidents. Whether caution is evidenced by the provision of mechanical appliances by the employer, or by greater care by the employe for his own safety and for that of his fellow workmen, the sense of caution must be recognized as the chief factor in accident prevention.

Safety—the state of being safe—of being free from physical injury—in its broader sense simply is a condition whereby men live longer and suffer less. It is protection, security. It means immunity from accidental mishap. It means human conservation. It is the fragrant

Spread the Word

MANY reasons, industrial, social and economic, exist for the active propagation of the safety first movement. Every person connected directly or indirectly with the industrial field should consitute himself or herself an active agent in fostering such a worthy object. Actual carrying out of a safety program in a plant depends almost entirely on the foremen. If they are sanguine, enthusiastic and genuinely interested they can secure observance of all the rules and regulations. They can develop a safety spirit in the men.

The accompanying article is abstracted from an address delivered recently by T. F. Jennings before the Utah Safety Society, at the Newhouse hotel, Salt Lake City, Utah. Mr. Jennings is foundry superintendent for the Utah Copper Co., Garfield, Utah. In the Jan. 1, 1929 issue of THE FOUNDRY *a placard was reproduced showing that the foundry under Mr. Jenning's charge had operated 1036 days with only two accidents and 404 days without an accident.*

flower which grows from the seed of care—the golden harvest of caution. Accidents will stop only when man accepts his full share of responsibility.

Customs change slowly. A few meetings and a few speeches will not revolutionize national or local opinion. Safety demands never ending activity. That is why it is necessary to keep saying it over and over again —to present the picture in constantly changing colors and new frames. The seed takes root slowly. Men's habits must change as a condition precedent to the flowering of safety. We are slowly uprooting the ancient fallacy that accidents are fore-ordained. The day will come when our safety structure will rise to great heights.

Who Pays For Accidents?

The workman pays for industrial accidents. He pays in bodily suffering and mental anguish. All too often he pays with life itself. He pays with years of struggle against the handicap of permanent injury. As the department of labor points, out, he pays four-fifths of the total direct cost out of his own wages.

The workman's family pays. Thousands of widows and fatherless children each year are the tragic victims of fatal industrial accidents. Poverty, sorrow, hardships, frail women condemned to hard labor for life; children deprived of education and driven to earn their bread. The workman's family pays a bitter price.

The employer pays. He pays the compensation insurance costs— one, two, three or perhaps a higher percentage of his payroll. He pays for plant doctors, hospitals, and all the safety expense as his part of the direct cost of accidents. He pays the cost of replacing injured men and training them for efficient production. He pays for the inefficiency of idle machines and short handed crews, for the confusion and time loss following each accident, for the fears which each accident creates in the minds of other men, for the lowering of their morale. Indirect cost of industrial accidents always is as great as or greater than the direct cost. In many industries these losses are not less than 5 per cent of the payroll.

The manager who has provided safeguards for every known point of danger in his plant, depends upon his foremen to do their full part to keep men from hurting themselves in jobs which cannot be guarded by mechanical means. To cite a single, simple illustration: Management can buy goggles, but only the foreman can make the men wear them.

The foreman who does not wage eternal war on accidents in his department is not only failing in his duty to his men but also is neglecting one of his best opportunities to keep down production costs. Indifference to or neglect of safety makes a foreman unworthy of his position of trust.

Accidents which justly can be ascribed to unpreventable hazards of industry become proportionately less as engineering skill in design of machinery develops and as better understanding of the handling of materials spreads.

Familiarity with anything is said

T. F. Jennings

to breed contempt. Workers are becoming too familiar with the ordinary, common hazards of industry. They are familiar with safety slogans which caught their eye and ear ten years ago. Now they pay no attention to them. Safety education among workers is no longer a matter of catch phrases, or of stimulation of temporary interest. It is a matter of hard-boiled actuality. A workman must be a safety man not only to safeguard himself but also his fellow workers.

Train the Foremen

The outstanding mistake that has characterized our safety work has been an over emphasis on what commonly is known as the physical hazard of work. Progress in safety has been retarded because of the wrong procedure in carrying on the work.

That wrong method is no where so apparent as in the over emphasis placed upon the hazard of the physical property. Only recently have we become appreciative of the importance of the proper selection, proper instruction, proper training and proper supervision of the men in industry as factors in accident prevention.

Importance of selecting the right man for the right place generally is conceded. We have lost sight of this side of the question. We have given too much attention and exerted too much effort toward the solution of the purely mechanical hazard. That plant is safest where a careful selection and a proper allocation of men are made. Mental and physical qualifications for the particular job must be taken into consideration. The new man must be instructed carefully how this work should be performed. Hazards involved in that employment should be pointed out. Subsequent training of the men includes safe practices, efficient operation and efficient service, and lastly an enforcement of, and obedience to the common sense safety rules that apply to that particular industry or that particular work.

These efforts well directed and continuously employed, will bring about safe operation and a good record for safety within the plant much sooner and in a more permanent manner, than effort directed wholly to the physical or equipment side of the property.

Announces Symposium on Steel Castings

A symposium on steel castings will be held at the 1932 annual meeting of the American Society for Testing Materials in Atlantic City, N. J. This symposium sponsored jointly by the American Foundrymen's association and the A. S. T. M. is the second on the subject of castings, the first, devoted to malleable iron castings, having been held at the 1931 A. S. T. M. meeting. The purpose of these symposiums is to procure and publish authoritative, critical data on engineering properties of casting—data of great value to all designers, producers and users of castings, which are not now conveniently accessible in any one publication.

The steel castings symposium will be a means of correlating and recording data on the properties of steel castings which are produced by widely used and accepted methods of manufacture including molding, casting, use of alloys and heat treatment. An imposing group of papers has been arranged for the symposium. The authors of the papers are well qualified to speak on their respective subjects from extensive contact with the casting industry. The plans for the program, not yet entirely completed, call for an introduction, a general survey of the steel casting industry and statistics covering steel castings which combined will give a general picture of the method of producing steel castings, an idea of the economic importance of the industry and other data of a nontechnical, but nevertheless important bearing in the steel castings industry.

Technical subjects will involve principles of design as related to physical properties; soundness and ease of production; problems in the heat-treatment of steel casting; and test bar specifications including the relation-

ship between physical properties obtained from coupons and the properties of the metal in the castings. One paper will give general data on steel castings and their fields of application governed by the various physical properties.

Will Present Data

Data will be included in this symposium on pearlitic steel castings; on iron-chromium, iron-chromium-nickel and related alloys; and on austenitic manganese steel castings. A paper on welding also will be included and will treat of welding from the standpoint of a steel foundryman.

The plans for the program and preparation of the symposium are being carried out by an advisory committee composed of the following: W. C. Hamilton, chairman, research director, American Steel Foundries; W. M. Barr, consulting chemist, Union Pacific Railroad Co.; George Batty, technical director, Steel Castings Development bureau; R. A. Bull, director, Steel Founders' Research group; J. A. Capp, engineer, testing laboratory, General Electric Co.; R. E. Kennedy, technical secretary, American Foundrymen's association; Fred Grotts, metallurgical engineer, Continental Roll & Steel Foundry Co.; J. H. Locke, assistant general manager, General Steel Castings Corp.; Jerome Strauss, chief research engineer, Vanadium Corp. of America; C. L. Warwick, secretary-treasurer, American Society for Testing Materials; G. B. Waterhouse, professor of metallurgy, Massachusetts Institute of Technology.

Handles Sand Mechanically in Car Wheel Foundry

CONVEYOR and sand handling equipment facilitates the production of 500 chilled cast iron railroad car wheels per day in the St. Paul, plant of the Griffin Wheel Co., with head office and two plants in Chicago and other plants in Boston, Cincinnati, Cleveland, Council Bluffs, Iowa, Denver, Detroit, Kansas City, Kans., Los Angeles, Salt Lake City, Utah, Tacoma, Wash.

Design Conveyor Equipment

On account of the large total tonnage and the weight of the individual castings, the conveyors, sand handling equipment and other mechanical features in a car wheel foundry are subject to severe conditions. Through a process of evolution and experiment the Griffin Wheel Co. has developed conveyor equipment particularly adapted to its specialized product. The company designed, manufactured and installed this equipment in its various plants, modified in each instance to meet local requirements. In like manner the Link-Belt Co., Chicago, designed and installed sand handling equipment to function in harmony with the other equipment in the St. Paul plant. The main storage bin, rectangular and with three compartments, was designed to occupy a space where the head room is limited.

The sand handling equipment begins to function at the shakeout station where the sand falls into a storage bin below the floor line. This storage bin is fitted with plate feeders agitated from the reciprocating shakeout conveyor below the hopper. This conveyor carries the sand which practically is red hot when shaken out and delivers it to a centrifugal discharge elevator which in turn delivers the sand to a revolving screen. This screen removes lumps of sand and other refuse. The riddled sand is delivered to any one of the three compartments in the main storage bin.

In effect, the three compartment storage bin is equivalent to three separate sand storage units. The sand in each compartment is removed and renewed in regular turn and thus remains undisturbed for a definite period after the bin is filled. By filling and emptying each compartment several times a day, assurance is had that dead sand will not accumulate and hang to the corners of the bin.

Water is added to the sand as it travels on a belt from the screen to the storage bins. If necessary, additional water is added to the sand as it travels on a transfer belt from the bins to the molding station where it falls into small hoppers.

A reciprocating bin feeder takes the sand from the storage bins and delivers it on the belts leading to the molding stations. This device feeds the sand from both sides and over the full length of a rectangular bin. The makers claim that it will feed either wet or dry sand at a uniform rate. It can be adjusted readily to vary the volume of sand handled, by adjusting the opening between the bin and feeder plates, by adjusting the length of the stroke or by changing the number of strokes per minute.

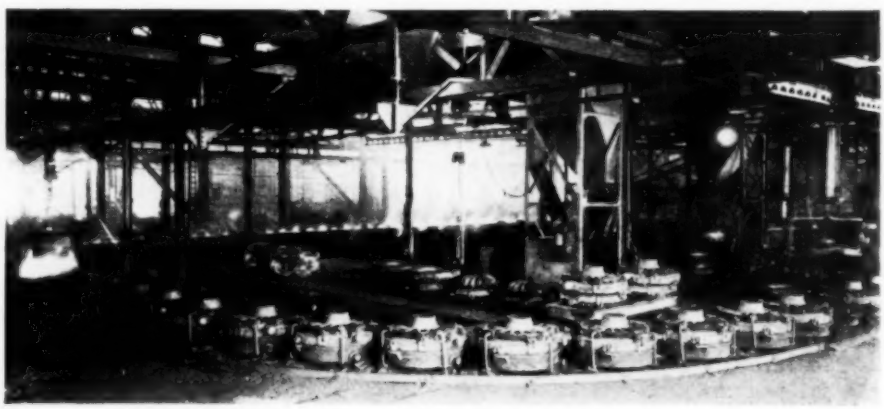
Prepares the Sand

Facing sand is prepared in a muller made by the National Engineering Co., Chicago, then passed through a blender made by the Royer Foundry & Machine Co., Wilkes-Barre, Pa., the facing sand is distributed to the hoppers over the molding stations, by the same conveyor system which distributes the remainder of the sand.

After the molds are made they are placed on a conveyor which takes them past the pouring station in the vicinity of the cupolas, as shown in the illustration, then through the cooling zone to the shakeout station. The castings are taken immediately to the annealing pits, the flasks are returned to the molding station and the sand started to the storage bins as described.

Acquire Pig Iron and Coke Business

Pickands, Mather & Co., Cleveland, have acquired the pig iron and coke sales business of Pickands, Brown & Co., Chicago, and admitted four former executives of the Chicago company to firm partnership. The new partners of Pickands, Mather & Co. are C. P. Wheeler, formerly president and one of the early partners of Pickands, Brown & Co.; Seymour Wheeler, former vice president of the company in charge of pig iron sales; Donald Boynton, former vice president in charge of coke sales, and Clifford D. Caldwell, president of the Interlake Iron Corp. and a former vice president of Pickands, Brown & Co.



The Wheel Molds Travel on a Conveyor Which Takes Them Past the Pouring Station in the Vicinity of the Cupolas. The St. Paul, Minn., Plant of the Griffin Wheel Co., Has a Capacity of 500 Wheels Per Day

Questions & Answers on FOUNDRY PRACTICE

GENERAL

Use Coke from the Drop

One of our superintendents reuses all the coke in the cupola drop, while a second superintendent does not use similar material. We shall appreciate your advice on which of these methods is considered usual foundry practice.

The great majority of superintendents and foremen are satisfied with material that is reasonably clean; material that will answer the purpose for which it is intended. Coke that has passed through the cupola loses a certain amount of its carbon content, and therefore, bulk for bulk, is not as efficient as coke in the virgin state. If the coke is unusually high in carbon in the original state, it still will serve satisfactorily for melting iron even though a small part of the carbon has been removed before it reaches the cupola drop. Under ordinary operating conditions the amount of coke recovered from the drop rarely is more than sufficient to make up one charge. This amount scattered over the coke pile, or distributed one or two forkfulls to each charge, will not adversely affect the usual operation of the cupola. In some foundries the coke from the cupola drop is utilized for firing the core and mold ovens.

Q & A

Aluminum Graphitizes

Can you give any information on the extent that aluminum will graphitize iron? The effects of silicon and nickel as graphitizing agents are known, and I thought perhaps there are some data on aluminum. I want to use aluminum on all steel mix if it will precepitate the graphite to the extent of making it machinable.

Aluminum in its effect on graphitization is similar to silicon according to an investigation by Melland and Waldron. Additions of aluminum, like silicon, reduce the total carbon and precipitate the graphite. The results obtained in their investigation were variable, and it appears that aluminum additions in excess of 0.50 per cent increased the stability of the carbide, and prevented the precipitation of graphite. Melland and Waldron suggested that the reason for the stabilization of the carbide was that a double carbide of iron and aluminum was forced when considerable carbon is present.

In addition to being a graphitizing agent, aluminum also acts as a deozidizer or degasifier, and often has been used in that capacity with gray or white iron. In one foundry making hard iron balls from an all steel mix, aluminum is used regularly in the mixing ladle at the spout. A piece of aluminum weighing about 4 or 5 ounces is dropped in the ladle just before tapping, and another at about the middle of the heat. That procedure eliminated the acrid smoke and gases that arose from the metal.

The late Dr. Moldenke in 1891 experimented with aluminum on dead white iron and found that increasing additions of that element caused graphite precipitation. The original white iron, aluminum-free showed 0.09 per cent graphite and 2.73 per cent combined carbon. Increasing additions changed the ratio until on the addition of 1.04 per cent aluminum, the graphite content was 2.01 per cent and the combined carbon 0.78 per cent.

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall
Cast Steel

H. A. Schwartz
Malleable Cast Iron

J. W. Bolton
Gray Cast Iron

All questions must be addressed to the Editor, The Foundry, Penton Building, Cleveland.

Q & A

Use Charcoal in Cupola

Can you give us complete data on melting iron in the cupola with charcoal, data to include cupola construction, blast pressure and volume, melting ratios and speeds, height of bed and melting zone and any other information applicable to the subject.

Complete data, or for that matter any data on melting iron in the cupola with charcoal are not available for the simple reason that charcoal never has been used for this purpose in modern practice. The cupola as we know it has been in use for only approximately 100 years and during that time coke and anthracite have been employed. In the early days of iron melting, the castings were poured direct from the iron melted in the blast furnace. Later the iron was remelted in reverberatory furnaces fired with bituminous coal. This form of furnace still is employed to a considerable extent, particularly in foundries where rolls and other forms of heavy machinery are made.

The Chinese employ a primitive form of cupola in which charcoal is used for fuel. However its scope is limited to melting 100 or 200 pounds of iron. Traveling tinkers employed a somewhat similar device while plying their trade in England in the early

days of the nineteenth century. The entire amount to be melted was placed in the cupola with a sufficient amount of fuel. When that amount was melted and tapped the heat was over. No such thing as indefinite charging of alternate layers of iron and fuel. Scarcity and cost constitute the two principal reasons why charcoal is not employed as a cupola fuel. The following extract from *Principles of Iron Founding* by the late Dr. Moldenke touches on this point:

"The records of cupola melting with charcoal as practiced in Sweden in the early foundry days are of great interest. The earliest pseudo-cupolas melted 100 pounds of iron with 55 to 75 pounds of charcoal—the melting loss being 5 to 9 per cent of the metal. The more modern constructions did not do so much better, for Karsten mentions 50 pounds of charcoal as melting 100 pounds of iron ordinarily, but when the pig iron was fusible with difficulty, it took 66 pounds of charcoal. An East Prussian charcoal blast furnace, when used as a cupola for simple melting did its work with 36 pounds of charcoal per 100 pounds of iron.

A limited amount of high grade pig iron, known as charcoal iron is produced in blast furnaces where charcoal is employed as fuel and we are wondering if you are confusing the two processes.

GRAY IRON

Shrinkage Is Defined

Is the crystallization of cast iron or the formation of cleavage lines one of the causes or cause of shrinkage? What is there to the theory that waters of varying amounts may be the cause of blowholes?

A shrinkage defect has been defined by one of the leading metallurgists as a cavity resulting from differential crystallization and varying rates of contraction. Liquid gray iron occupies a greater volume per unit of mass than when it is in the solid state. As it freezes crystals are formed beginning at the exterior surface and extending toward the interior. The crystals formed first are comparatively low in carbon, and the remaining liquid is richer in carbon. The crystals grow larger in layers with each layer richer in carbon. At the eutectic temperature, the residual material solidifies. However, unless additional hot iron is supplied by risers, gates, etc., to replace that which has crystallized, a cavity will occur in the center as the volume of solid metal is less than that of the hot metal poured into the mold.

Your reference to waters of varying amounts presumably means moisture in sand, and excess moisture usually causes blowholes. The dryer you can use molding sand, within reason, the less trouble you will encounter. Fat sands or those high in clay bond will need more water to produce the proper working consistency gaged according to the sense of touch, and that quantity of water may be too great to obtain good results when molten metal lies against it. Therefore, it is advisable to reduce the amount of bond by adding sand without any bond, or with low bond content, to the point where sufficient bond is present for the work in hand, but not greatly in excess. Also sands high in clay tend to be dense, and cause difficulty in venting the mold properly.

Q & A

Uses Pig and Scrap

Can you tell us whether a mixture made entirely of pig iron with an analysis, silicon, 3.0 to 3.5 per cent, sulphur, 0.05 per cent, phosphorus, 0.05 per cent, and manganese, 0.50 to 1.0 per cent, is better than a mixture made of 80 per cent cast iron scrap and 20 per cent pig iron when used in making ingot molds for brass slabs?

The data furnished in your recent inquiry are not sufficient on which to base a positive opinion. However, assuming that certain materials and conditions are similar to those with which we are familiar, we suggest you use the 80 per cent scrap, 20 per cent pig iron mixture rather than the straight pig. This is on the assumption that the scrap is old ingot molds and that the pig iron is the same pig iron for which you give the analysis. A certain amount of good machinery scrap might be added, if proper discretion is observed and if the melter keeps in mind that the phosphorus and sulphur in the resulting casting must be held to a minimum. Ordinarily a low silicon content is desirable, coupled if possible with a low carbon content. If the molds are cast to shape with no machining involved, a white iron or a mottled iron is better than a gray iron. If the 80-20 mixture shows a gray fracture, the addition of 0.5 to 1.5 per cent chromium in the ladle will prove beneficial. If the molds are to be machined, a silicon content of 1.50 to 2.00 per cent is sufficient.

Problems in Nonferrous Founding

By Charles Vickers

Requires Plating First

We would like to obtain information regarding the type of solder to use in making aluminum bronze core boxes. It is quite necessary that we have some sort of solder that can be used readily with aluminum bronze, namely an alloy of 89 per cent copper; 10 per cent aluminum and 1 per cent iron.

Perhaps one of the commercial aluminum solders will do the job of soldering aluminum. If not, then it cannot be soldered readily. The method largely used is first to copper or nickel-plate the bronze. Then regular soft solder readily sticks to the plated part.

Q & A

Bushings Hard To Core

We are making bronze cored bars 12 inches long with varying diameters. The cores are ½-inch in diameter, and our difficulty has been in obtaining a straight hole. Can you tell us the prevailing method for making such bars, and a suitable core mixture for use in a sausage type machine?

Bars with such small holes as you mention usually are machined from solid bars for several reasons. The first is that which you have found; not being able to obtain a straight hole. Second, if the metal has a tendency to burn into the cores, difficulty is encountered in obtaining a clean hole, and trouble is met in machining the holes. The third is the core themselves. The cores must be stiff, but not so much so that they will not yield to the metal. Otherwise, you will not be able to remove the cores from the hole. The cores should be made only of sharp or silica sand without any molding sand, and should contain a vent through the center about ⅛-inch in diameter.

Undoubtedly you can obtain accurate information from the maker of your core machine on the most suitable mixture for it. Usually more binder is required for small diameter, long cores to give them rigidity. However, you might try the following mixture: 80 parts of silica or clean sharp sand, 1 part of good quality core oil, and 2 parts of corn flour.

To obtain as straight a hole as possible in the castings, it will be necessary to pour them vertically, and gate from the bottom. While a three-part flask may be used with the gate cut in the drag, the easiest method will be to cut a hole in the ends of the flasks at that point where the sprue will be located, and mold the bushing horizontally. After the mold is clamped, it is up ended and poured. Also see that a vent channel is cut from the core to the flask, and a cut made in the flask at that point to permit easy egress of the gases.

The FOUNDRY Family Photograph Album

Upper Left
JOHN A. MARR
Chicago Steel Foundry Co.,
Chicago

Upper Right
CARL E. SCHUBERT
University of Illinois
Urbana, Ill.

Lower Left
JAMES G. PEARCE
British Cast Iron Research Association
Birmingham, England

Lower Right
T. A. MALONEY
St. Louis Gas & Coke Corp.,
St. Louis

BILL

By Pat Dwyer

Outlines Several Available Methods

CONTRAST of a bright, warm interior with a biting wind that hurled powdered snow against the windows, led me to volunteer the remark that this indeed would be a poor night in which to float across the lake on a shingle. Certainly I had no intention of embarking on such a foolhardy undertaking, either on that night or on any other. The statement simply was an emphatic way of saying that the temperature was hovering around the zero mark and the wind was blowing at a rate that would penetrate an eskimo's fur overcoat and cause the aforesaid eskimo to shrink to approximately half his natural size.

The statement also served another purpose in that it called to mind the originator of the saying and some of the bitterly cold days which prompted him to use it. The phrase, like practically all famous phrases is adaptable and fits readily into the local environment. In the original form with the usual profane streamers and grace notes removed the statement conveyed the general impression that a whole hearted and unanimous vote of sympathy was due any person unfortunate enough to find himself floating around the gulf on a shingle on that particular day or night.

Reference to the gulf, obviously was prompted by the fact that the gulf of St. Lawrence was the nearest large body of navigable water. Also the originator of the saying, or at least the first man to use it in my presence, had lived in that vicinity all his life and probably regarded the gulf of St. Lawrence as the largest and most important expanse of water in the world. The type is not uncommon and by no means confined to any one section of the country. By some peculiar mental legerdemain the average citizen is able to convince himself that the locality in which he happens to reside—usually by accident or through circumstances over which he has no control—possesses advantages or special features not enjoyed by any other place on earth.

In this particular instance I substituted lake for gulf because the lake lies at the front door of the city which has claimed my allegiance for many years. Also because as patriotic citizens we claim that a storm over Lake Erie throws the water higher, wilder and colder than in any other link of the Great Lakes chain. The loudest protesters are those who never have seen any of these other lakes, or, who have not seen them when the long waves are flying under the merciless lash of a piercing northern gale.

Just as I had expected, the remark although applying to the lake, carried Bill's mind back to the old days near the gulf and to the brand of weather

Back in the Good Old Days When Rabbits and Bananas Were Sold in Bunches

that brought forth references to navigating that dreary stretch of water on a shingle.

"Well," he said, "I'll tell you. Either the weather or I has or have changed in recent years. When I was a kid winter set in in October and lasted until April at least, in the following year. Seems to me that winter was reckoned to be about half over by the time Christmas arrived. I bought a pair of skates before Christmas one winter, from the sale of a dozen rabbits I had snared in the woods and I am sure you never heard of any person setting rabbit snares until after the rabbit spoor could be followed in the snow.

"In the good old days the ice on the river never was less than 3 feet thick and the snow drifts were up to the eaves of the houses. When a man with a horse and sleigh drove a few miles to visit a neighbor, he might return the same day and he might be detained for a week. In a word, my lad, winter was winter in those days and not the pitiful imitation that passes for winter in recent years."

"Far be it from me," I interrupted at this point. "Far be it from me to start any argument over the severity of the ancient winters, but is there not just the faintest possibility that early impressions have left exaggerated pictures in your mind? I can remember certain topographical features that loomed large at one time, but which seemed to have shrunken woefully by the time I set eyes on them again many years later. The winters that looked like a section of the Arctic regions to you as a boy, might not seem so formidable if you could turn the clock back and see them now."

"The point is well taken," Bill conceded generously, "but it so happens that I saw a picture lately which indicates that even the severe winters of my early days were not one, two three when compared with the winters of 300 years ago."

"Why stop at 300 years?" I naturally inquired. "Why not go back to the dear old days when the polar ice cap split up into 1000 huge glaciers that started creeping toward the South and freedom? When mammoths and saber-toothed tigers played tag with each other and playfully bit large painful hunks out of any human beings who ventured in their path."

"This picture I am telling you about was shown on the screen of a local theater to illustrate a musical composition dealing with the landing of the Pilgrims on Plymouth Rock. The hardy pioneers were shown perched on top of a boulder about the size of a two-story cottage. The MAYFLOWER was shown in the far distance and allowing for the perspective she must have been slightly longer than the BERENGARIA. The space between the ship and the shore was packed with broken ice in assorted sizes from 4 to 40 feet.

"The voyage of the MAYFLOWER and the landing of her passengers on a bleak and lonely shore, November, 1620, is an epic of strength, endurance and courage and a bitter commentary on the intolerable conditions in a home land that forced these people to emigrate. However, if Cape Cod bay contained even half the ice shown by the artist, I am afraid the passengers must have landed from an airship, or been carried ashore in a cargo sling suspended from an aerial railway.

"Gazing at the rock one day last summer I was surprised to find it had shrunk to about the size of a dining

room table. The lady who was with me was not impressed. 'Up in Vermont, yesterday,' she said, 'we saw millions of rocks that were rocks and no one paid any attention to them!'

"One feature about this rock that offended me, this rock that stands as a shrine, an emblem of equality and freedom, is the presence of a small band of barkers who take turns in delivering a short sing-song recital of the history. Then each one takes turns in passing the hat for a collection. This rock marks the landing place of heroic men and women who risked their lives in protest against all manner of servility, sycophancy hypocrisy and boot licking of a caste system and now their memory is commercialized by a bunch of parasites.

"Contemplation of that kind of stuff," said Bill, "is enough to give a fella the pip. Let's talk about something cheerful. I had an inquiry from a lad the other day who wanted me to outline the best method for molding, gating, pouring, etc., a gray iron casting 5½ inches diameter and 6 feet in length. It must be perfect in every particular. It is to be finished all over with spiral grooves cut in the face. The present pattern is split longitudinally.

"Several methods are available for making the casting outlined and each one will produce a satisfactory casting under certain conditions. The method adopted or the best method to adopt depends on these conditions including the number of castings on order, available type of flasks, ovens, sand and the familiarity or lack of familiarity of the employes with the various processes.

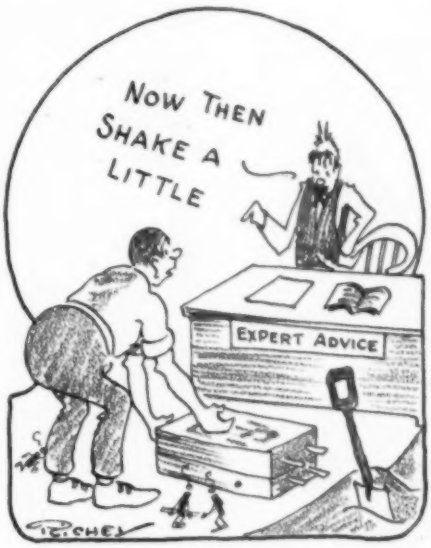
"If only one or even a few castings are ordered they may be made in green sand in a horizontal mold from a split pattern, one-half in the drag and one-half in the cope. Two risers 3 inches at the neck, 4 inches diameter below and 6 inches above and located about 18 inches from each end of the casting will serve to introduce feeding iron while the casting is shrinking.

"The best type of gate is that known as the pencil gate. The casting will weigh 448 pounds and that amount of metal can be poured quite readily through four ½-inch pencil gates located in a group near the top center line of the casting. Preferably these gates should be formed in a block of dry sand, but with proper care, green sand will serve. Great care is required in making up the runner basin and the gates to prevent the entrance of any foreign material. The risers are built up at least 12 inches above the highest point of the casting. Needless to say a strong, stiff, flask and bottom board are required to prevent the mold from straining. In this instance an iron or steel flask is preferable to one made of wood. Wood will serve, but it must be braced or clamped laterally as well as perpendicularly.

"Green sand presents certain hazards except in the hands of exceedingly skillful molders and for that reason many foundrymen prefer to dry the molds for castings which have to be machined extensively and have to be perfectly clean and solid. If he is equipped with the necessary sand and oven he may find that drying the mold is a worth while form of insurance. The gating, pouring and feeding methods are similar to those outlined for the green sand mold.

"An alternative method would be to fasten the halves of the pattern together, make the mold on end and draw the pattern straight up out of the mold. The mold is made 6 or 8 inches longer than the pattern to provide head metal for feeding the casting. The metal can be poured directly into the open top of the mold. A small stream at first until a pool is formed at the bottom. Then the remainder of the metal is poured rapidly to prevent adhesion of any foreign material to the wall of the mold. This is the simplest of all methods for making this particular casting—provided the sand is highly permeable and equipment is available for drying the mold.

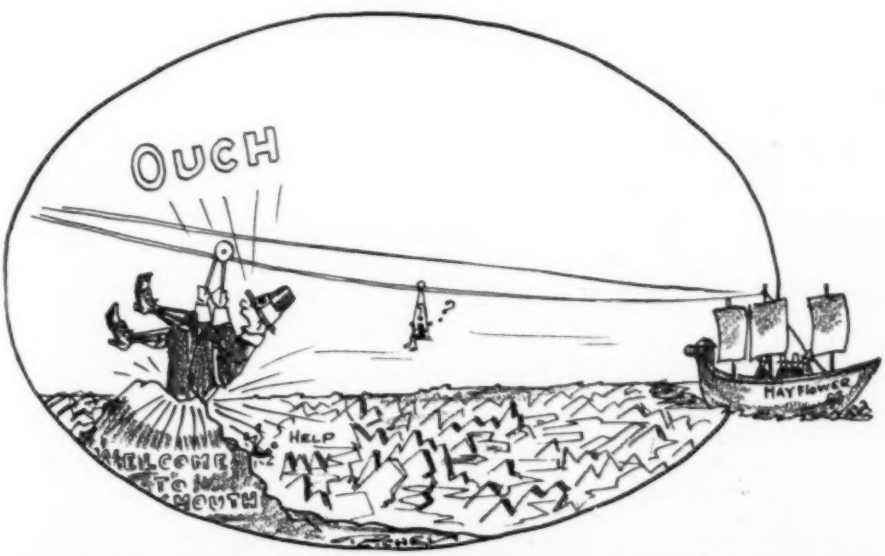
"Castings of this kind sometimes are made in two part flasks with a long sprue and a gate at the bottom. The mold is made and dried in a horizontal position. Then it is closed and turned up on end before the metal is poured into it through this long sprue terminating at a gate at the bottom. The method is satisfactory so far as producing a good casting is concerned, but the amount of work involved is excessive and therefore the cost is too high.



Apparently What the Lad Needs Next Is a Lift

"In the one-piece mold, a number of small flasks, round, oblong or square may be pressed into service and built up to the desired height. If necessary a section of 10-inch pipe, iron or steel, will serve for a flask. It is pierced for ¼-inch vent holes at 6-inch intervals. With 6 inches of sand rammed in the bottom, the pipe will require no bottom plate. The pattern is centered in place and sand is rammed all around it. The pattern is removed and the mold is dried. Afterward the lower end is buried to a depth of a foot or two in the floor before the metal is poured into it.

"A method sometimes practiced for making castings of this kind where facilities are lacking is to enclose sheet iron or sheet steel forms in sand. In this particular instance a few lengths of stove pipe might be erected in the center of a round or square flask built up of several sections. A coarse grade of sand is rammed around the stove pipe to insure easy and rapid escape of gas and steam. The metal is poured directly into the open top of the mold. The stove pipe coating will stick to the face of the casting, but it will be removed with the first cut of the tool in the machine shop."



The Shore End of the Cable Was Made Fast To One of the Famous Nutmeg Trees

A. F. A. Awards Penton Medal To L. W. Spring

H. W. Gillett To Receive McFadden Gold Medal—Presentations To Be Made During Philadelphia Convention And Exhibition in May

LaVerne W. Spring

LAVERNE W. SPRING, chief chemist, Crane Co., Chicago, will be presented the John A. Penton gold medal and Dr. H. W. Gillett, director, Battelle Memorial institute, Columbus, O., will be given the W. H. MacFadden gold medal during the annual convention of the American Foundrymen's association in Philadelphia, May 2 to 5, for outstanding service to the foundry industry. These awards, which are made upon recommendation of the board of awards and approval of the board of directors, represent two of the four medal awards established in 1920 through grants of funds by four past officers of the association. The board of awards, which selects the recipients of the medals, consists of a committee of seven past presidents of the A. F. A.

Signifies Vision in Service

The John A. Penton medal signifies vision in the service of the industry. Since its establishment in 1920 by Mr. Penton, first secretary of the American Foundrymen's association, founder of THE FOUNDRY and chairman of the board of the Penton Publishing Co., the medal has been awarded to Enrique Touceda, at the Milwaukee convention in 1924, to John Shaw of England at the Detroit meeting in 1926 and to Harry A. Schwartz at the Cleveland convention in 1930.

The significance of this medal is ably expressed in the accomplishments of Mr. Spring and his service to the foundry industry. A native of Coldwater, Mich., he attended the University of Michigan and was graduated with an A. B. degree in chemistry. After serving for some time as chemist with the Illinois Steel Co., South Chicago, Ill., he accepted a similar position with the Wolverine Portland Cement Co. Later he returned to the Illinois Steel company to undertake metallurgical and superintendency work in the plate mill. In 1906 he became connected with the Crane Co., Chicago, serving first as chemist. Later he was placed in charge of the laboratories and in 1914 he was advanced to the position of chief chemist and metallurgist.

Mr. Spring is the author of the interesting book *Non-Technical Chats on Iron and Steel*, the first edition of which was published in 1917, the revised edition appearing in 1927. He also has written extensively for the technical press and engineering associations, being the author of the 1931 A.F.A. exchange paper for the Institute of British Foundrymen. The subject of the paper was "Considerations and Tests for Cast Materials for High-Temperature High-Pressure Service," and represents a field in which Mr. Spring has done extensive research work. Some of his earlier articles beginning in 1909 were on such subjects as "Determination of Iron in Brasses and Bronzes," "Nickel-Zinc Separation in German Silver and Other Alloys," "The Effect of High-Temperatures on the Physical Properties of Some Alloys," "Tests with Cerium in Red Brass and as a Deoxidizer and Desulphurizer in Red Brass, Cast Iron and Converter Steel," and "Advancement in the Manufacture of Steel for Castings."

Later articles and papers cover such subjects as "Industrial Application of Metals at Various Temperatures" (A.S.T.M. 1924), "Accuracy in High Temperature Testing of Materials" (with J. J. Kanter, *Power*, 1925), "A Quick Qualitative Test of Nickel Steel or Alloy Steel Bars Containing Nickel" (with E. W. Hutchinson, A.S.S.T. 1925), "Testing Flow in Metals at Various Temperatures" (with H. W. Maack and J. J. Kanter, *Valve World* 1927), "Comparative High Temperature Tension Tests on a Carbon Steel and on a Chrome-Molybdenum Steel" (with H. J. French, *Mechanical Engineering* 1927), "Long Time or Flow Tests of Carbon Steels at Various Temperatures" (with J. J. Kanter, A.S.T.M. 1928), "Cast Iron is Looking Up" (*Chemical Bulletin* 1928), "Stainless Steels and Irons and a Steel which is Stainless though not a 'Stainless Steel'" (*Chemical Bulletin* 1929), "Metallurgy of Valve, Fitting and Piping Materials" (with H. W. Maack, *Metals and Alloys*, 1930), "Some Long Time Tests of Steel at Elevated Temperatures" (with J. J. Kanter, A.S.T.M. 1930), "Progress in Metals" (*Metal Progress* 1930), "Materials for High Temperature Service from the Creep Design Standpoint" (with J. J. Kanter, *Metals and Alloys* 1930), and "High Temperature Metals for the Power Plant" (Midwest Power Engineering conference 1931).

Member of Many Committees

Mr. Spring holds membership in many technical associations and has rendered valuable service in technical committee activities. He is a member of the A.F.A. committees on cast iron, nonferrous metals, and malleable iron, and represents the association and the American Institute of Mining and Metallurgical Engineers on the advisory committee to the bureau of standards. He serves on the advisory committee of the A.S.T.M. committee on steel, is chairman of the A.S.T.M. committee A-1, sub-committee XXII on valves and fittings for high temperature service, is a member of A.S.T.M. committees A-3 on cast iron, A-7 on malleable cast iron, A-10 on iron-chromium, iron-chromium-nickel and related alloys, B-5 on copper and copper alloys, cast and wrought, and is a member of the joint A.S.T.M.—A.S.M.E. committee on research on effect of temperature on the properties of metals. He is also a member of the American Society for Steel

Treating, American Chemical society, Institute of Metals (British) and the American Institute of Mining and Metallurgical Engineers.

The Wm. H. McFadden gold medal previously has been awarded to Robert J. Anderson at Syracuse in 1925, and posthumously to Alexander E. Outerbridge Jr. at Philadelphia in 1928. The donor, an honorary member of the association, served as its president from June, 1906 to May, 1907.

Dr. H. W. Gillett, recipient of the medal for 1932, has been prominent in research work connected with various branches of metallurgy, working with various cast alloys.

Has Wide Experience

Receiving an A. B. in chemistry from Cornell university in 1906, he continued his studies at Cornell and in 1910 was granted the degree of Ph. D. for his work in physical and electro-chemistry. In the summer of 1906, he served as chemist with Thomas A. Edison, Inc. and in 1907-1908 he was connected with A. D. Little, Inc. in a similar capacity. During the years 1906 to 1910 he also served as instructor in the chemical department of Cornell university.

He then spent two years manager of the research department, Aluminum Castings Co., Detroit. Because of his work along that line he was appointed alloy chemist and later chief alloy chemist of the United States bureau of mines, being in charge of the Ithaca field office until 1924. During that time he worked on brass melting, development of the rocking electric furnace, electric smelting, molybdenum and other alloy steels, and endurance of metals.

Dr. H. W. Gillett

In 1924 Dr. Gillett was appointed chief of the division of metallurgy, bureau of standards, supervising the work on physical metallurgy of ferrous and nonferrous alloys. In 1929, when Battelle Memorial institute was established, Dr. Gillett was made director, a position which he now holds. This institution, which specializes in the fields of metallurgy and fuels, carries out research both upon projects supported by its own endowment funds and upon those sponsored by industry. Several of the projects being studied at Battelle are related directly to the foundry industry, such as high temperature properties of alloy cast irons, foundry refractories, combustion of pulverized fuel, foundry sands, bearing metals, cast steel, cast iron and cast copper-base alloys.

In addition to holding membership in the A.F.A., Dr. Gillett is a member of the American Institute of Mining and Metallurgical engineers, American Society for Testing Materials, American Chemical society, American Electrochemical society, British Institute of Metals, and British Iron and Steel institute. He also is a member of several important committees, such as National advisory committee for aeronautics, metallurgical advisory committee U. S. bureau of standards, advisory committee chemical warfare service, alloys of iron research of the engineering foundation, A.I.M.E. research committee, A.S.T.M. committees on nonferrous metals, die cast alloys and fatigue of metals, the joint committee on effect of temperature on properties of metal and the A.F.A. committees on cast iron and liquid shrinkage.

Dr. Gillett has been a contributor to many technical publications and in collaboration with E. L. Mack, has written a book on *Molybdenum, Cerium and Related Alloy Steels* as well as contributing chapters on "Colloid Behavior" to the books on *Chemistry in Industry and Nonferrous Metallurgy.* His bulletins and technical papers for the bureau of mines cover such subjects as "Brass Furnace Practice" "Electric Brass Furnace Practice," "Ferro-Uranium, Electric Smelting of Manganese Ores," "Experimental Production of Alloy Steels," etc. His contributions to the bureau of standards publications covered such subjects as "Light Metals and Alloys," "High Silicon Structural Steel," etc.

To Sell Foundry Sand

George A. Doughten has opened an office at 300 Broadway, Camden, N. J., to deal in foundry sand, clays, facings, etc. Mr. Doughten for the past five years was sales manager of Geo. F. Pettinos Inc., Philadelphia. His active business career began in January, 1906, when he was employed by the Standard Steel Works Co. in its Philadelphia office. After various positions with this firm, he resigned in 1919 to enter the employ of the Pettinos organization.

Quad City Founders Study Feeding

Hyman Bornstein, metallurgist, Deere & Co., Moline, Ill., was principal speaker at the regular monthly meeting of the Quad City Foundrymen's association held Dec. 21 at the Fort Armstrong hotel, Rock Island, Ill. Seventy-five members were present.

Mr. Bornstein explained that the material for his talk on "Feeding Castings" had been gathered from various papers presented at past conventions of the American Foundrymen's association; and from E. V. Roncerary's paper given at the 1930 A. F. A. convention. He also drew largely on a series of articles, "Prevent Losses with Proper Gates and Risers," by Pat Dwyer, which have been appearing in THE FOUNDRY during the past year.

Mr. Bornstein opened his talk by explaining the momenclature, as brought out by Mr. Ronceray and Mr. Dwyer. Slides also showed the various channels of admitting the iron into the mold proper, with the names indicated for the various parts. The speaker pointed out the difference between English practice and American practice and also discussed the difference between the practice followed in the automotive and agricultural implement shops and the general foundry industry. With the aid of charts taken from an A. F. A. paper by H. W. Dietert, the speaker showed how to calculate the area of the gate necessary to run a certain type of casting, and explained that similar graphs could be made for any given set of conditions. He also spoke on the fluidity of various types of metal which are used commonly in the foundry.

Preceding the speaker of the evening, A. E. Hageboeck carried out a new feature of the monthly programs with a five-minute talk on "The Gray Iron Institute and Its Personnel." He described the background of the institute and gave an interesting talk on the duties and functions of the various departments of the institute.

Elect New President

The American Chemical society which each year elects a president and president-elect who serve in successive years, has elected Prof. A. B. Lamb, Harvard university, Cambridge, Mass., as president for 1933, and Dr. L. V. Redman, Bakelite Corp., Bloomfield, N. J., as president for 1932. E. M. Billings, Eastman Kodak Co., Rochester, N. Y., was elected director for the second district, and Prof. Roger Adams, University of Illinois, Urbana, Ill., director for the fifth district. Councillors at large who were chosen include G. J. Esselen, Boston; Prof. R. A. Gortner, University of Minnesota, Minneapolis; Prof. E. E. Reid, Johns Hopkins university, Baltimore, and E. R. Weidlein, Mellon Institute of Industrial Research, Pittsburgh.

Design of Pattern Equipment Affects Bids on Castings

By P. C. Rogers

A POSSIBILITY exists of encountering a loss on castings through submitting prices based entirely on the blueprint. The blueprint may have been prepared with great care by the prospective casting purchaser and without any attempt on his part to conceal any important factors, and still it may be lacking in essential information. Every foundry is familiar with this type of blueprint forwarded in connection with request for estimate on a casting, or on a lot of castings. The estimator has to use his imagination on what type of pattern equipment will be furnished if the job is placed with his foundry.

Must Use Imagination

The print received is generally of the usual type, showing plan and section view of casting desired, and it is left to one's imagination to assume how the pattern will be made. Only rarely the blueprint will have any notation as to how pattern equipment is constructed.

Further, usually the average purchasing agent does not know or cannot furnish proper pattern information offhand. The foundryman does not bother the buyer, but assumes from past experience with similar jobs that the pattern equipment will be built according to ideas he has in mind. Ordinarily he quotes on this basis, without stipulating the pattern equipment he expects to receive and on which his costs have been based.

Should he receive the order and the pattern equipment is found to be different than expected, he either tries to fix the equipment in his own shop to suit his needs, which means expense he did not figure on, or perhaps he gets in touch with the customer and makes a mild complaint. Seldom does he get any satisfaction, much less financial assistance to help out on the extra work not anticipated.

In the three castings shown in the accompanying illustrations the pattern equipment furnished entailed extra operation and expense beyond that anticipated.

Fig. 1 shows a plain sheave. Most of us would feel sure that the only core work would be the main core in hub and the core for the outer groove. The spaces between the arms would be formed in the mold by the pattern.

As a matter of fact, this job required pasted segment cores for the outer groove, pasted cores for the spaces between the arms, and the main core in hub.

The foundrymen who took this job stated afterward that they were surprised that there was so much core work. They had not figured on it, yet the price had been quoted, and extra core cost was borne by foundry.

Is Not So Simple

From all appearances, the casting illustrated in Fig. 2 would seem to be a straight, plain molding operation with a plain, straight core in hub. There is nothing on the blueprint to indicate that other than a whole pattern would be furnished.

However, the pattern equipment actually consists of a sweep for the rim, and coreboxes, which make the inside, including the arms, and special core box for hub.

Familiarity with work from this customer led us to quote accordingly, but another company had expected to receive full pattern equipment, consequently quoted accordingly, and would have been seriously handicapped if obliged to use sweep and core equipment, and could not have maintained the cost figures that had been quoted.

Guess at Equipment

WHERE the pattern equipment supplied by the customer is not similar to the pattern equipment in the mind of the foundryman at the time of submitting prices on the work, an increased cost of delivery of the castings confidently may be anticipated. Typical examples are presented to illustrate this point. Usually if the foundryman is consulted he can suggest a type of pattern best suited to the work from the customer and foundry view point. This article is abstracted from a paper presented before the New York meeting of the Steel Founder's Society of America. The author P. C. Rogers is general manager, Roxbury Steel Casting Co., Boston.

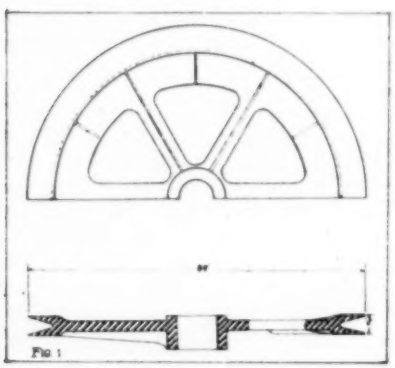


Fig. 1—Usual Type of Blueprint for a Sheave Casting Does not Indicate Type of Pattern

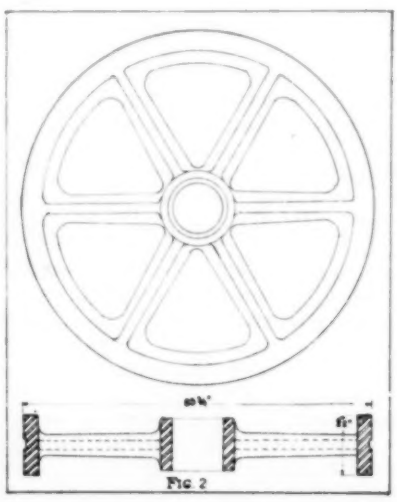


Fig. 2—A Sweep and Set of Coreboxes Were Supplied for Molding This 5½-Ton Gear

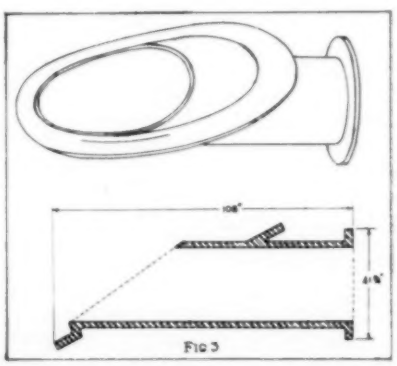


Fig. 3—A Solid Pattern Increased the Molding Cost on This Marine Casting

The casting shown in Fig. 3 was made for one of the large round-the-world ships. There were six of these, and six intake sea chests of a similar design although considerably more complicated and weighing approximately 6200 pounds each.

At the time of receiving the inquiry, and owing to the complicated drawing covering this work, we inquired of the purchasing agent how the pattern equipment was to be made, only to learn that at the time they did not know themselves. We made up our estimate based on a split pattern with the idea of having the flange loose in the cope and nowel, which gave us the simplest and easiest molding operation and best feeding opportunity. In quoting advised our customer that our price was based on pattern equipment made accordingly. We received the order, and the price we had quoted was prominently affixed in the margin.

Make a Solid Pattern

A short time afterward I had occasion to visit this customer, and in going through the pattern shop noticed that a solid pattern was being constructed. I immediately called the attention of the superintendent of the pattern shop to this fact, explaining that we had quoted on the basis of a split pattern. He had not been informed of this fact, and could not make a split pattern. The flange had to be made from a template taken from the hull of the ship, and the exact contour maintained. They could not machine this flange. It had to fit as cast.

Needless to state, we were thankful we had stipulated in our quotation the pattern equipment we expected to receive. We found a much more difficult job to deal with than originally supposed.

The flange was molded flat and the joint of the mold brought down to it, necessitating drawbacks to overcome the backdraft at the bottom of the tube. The feeding also became a much more difficult proposition.

With this pattern equipment in mind, I explained the situation to the purchasing agent. We were obliged to withdraw our original quotation as the pattern was not made in accordance, and named a new figure which covered the extra work.

After considerable protest from the purchasing department the shop requirements prevailed. We got our advance in price and supplied the castings to the firm.

Similar situations are familiar to all. Possibly interpretation of a blueprint has differed from the pattern equipment received to the extent of changing what appeared to be a prospective profit to an unexpected and unforeseen loss.

Possibly opinions or suggestions may be obtained that in the future will secure the co-operation of buyers to the extent that they will make it a point to furnish a description of pattern equipment with their inquiries. Otherwise it would seem advisable for the foundry, when quoting, to stipulate the pattern equipment expected and on which the quotation is based.

Congratulations!

IT FALLS to a foundry in the Sunny South to carry the first courageous report of the New Year. Witness the following from the Superior Foundry Co., Columbus, Ga.:

On Oct. 26, C. O. Hoffmeyer and V. A. Self, both practical foundrymen, acquired the patterns and equipment of both the Dismuke Iron Works and Ledford Iron Works, Columbus, Ga., and are operating under the name of the Superior Foundry Co. The new firm manufactures a line of fire place furnishings, chilled plow repairs and general jobbing castings. Business has increased from 1 day per week operation the first of November to full time operation on Dec. 15. Orders and inquiries on hand indicate full operation for the first quarter of 1932.

Congratulations, Superior, and may the second quarter exceed the first.

By the way, the Superior company is one of numerous foundries helping the cotton growers of the South by writing letters on cotton cloth.

Study Chromium Plate

The porosity of electroplated chromium coatings was tested by Blum, Barrows and Brenner by depositing copper in the pores and cracks. It was found that chromium coatings crack rapidly during the first 24 hours and more slowly in the following few weeks. Deposits produced at 131 or 149 degrees Fahr. have a lower minimum porosity which does not increase as the thickness is increased. Under present conditions of plating, porosity is least when chromium is deposited on nickel and greatest on steel. The data is presented in research paper No. 368 which may be obtained from the superintendent of documents, Washington, for 10 cents.

Recommends Standard

To facilitate the replacement of valves in existing piping systems, standard center-to-face dimensions for ferrous flanged valves developed and approved by the Manufacturers Standardization Society of the Valve and Fittings Industry as standard practice have been recommended tentatively for adoption as a standard by the American Standards association. The valves covered are flanged wedge gate, flanged globe, and flanged angle valves from 1 to 24 inches for various pressures. Further information may be obtained from C. B. LePage, assistant secretary, American Society of Mechanical Engineers, 29 West Thirty-ninth street, New York.

Reports on Production

Gray iron foundry activities reflected the end of the year business decline in the November trade report compiled by the Gray Iron institute, 1400 Euclid avenue, Cleveland.

Production dropped from 47.6 per cent of normal in October to 37.1 in November, new business from 39.6 to 26.5 per cent and unfilled orders from 29.7 to 23.1 per cent, while production and new business dropped sharply below last year, unfilled orders at the end of the month were only 1.1 per cent under November, 1930.

Prevent Losses

(*Concluded from Page 33*)

one place to another unless it has to be replaced by a new one. No skilled mechanics are required to handle the molds. Six men set up, pour and shake out 130 molds, representing an average of 20,000 pounds of metal in 8 hours.

Casting losses from all causes fluctuate between 1 and 2 per cent. The cost of the molds runs from 2 to 3 cents per 100 pounds of castings produced. Any composition of brass or bronze may be cast in permanent molds. Alloys containing white metal, particularly lead, are most amenable to the process.

This is the twenty-fifth of a series of articles dealing with the various types of gates and risers used in the foundry industry. The twenty-sixth installment will appear in an early issue.—THE EDITORS.

To Manage Sales

R. L. Suhl has been made manager of the nickel sales department, International Nickel Co. Inc., New York, succeeding the late Frederick S. Jordan. Ransom Cooper Jr., Walter C. Kerrigan and Charles McKnight have been made assistant managers.

T. H. Wickenden, since 1922 in charge of the company's development work in the automotive and aeronautical fields, has been appointed assistant manager of development and research. H. J. French, since 1929 a member of the research staff at the company's laboratory at Bayonne, N. J., has been transferred to the development and research department in New York.

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The Shakeout

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CHARLES VICKERS
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¶ One Still Living

THOSE optimists are few who have survived the succession of socks in the midriff and the sleep inducing jolts to the jaw, administered by Kid Depression. Perhaps the survivors were slaughtered in cold blood by predatory gloom chasers, the ones who even in 1928 looked with jaundiced eyes on the male Pollyannas who chanted the song of ever blooming prosperity. The breed is rare, as the unlamented 1931 steps aside to permit the entrance of the new year. One optimist still lives. Buffeted and scarred, but jaunty and hopeful, the glad glamour of his smile is undimmed and he sells pig iron. Honor him, Foundrymen, although he remains unnamed. Greet your next salesman of this lowly commodity with courtesy, and thaw the icy stare, for he may be this surviving optimist, in person. Why does he retain his faith? Because, the first week of the present year of grace sees more tonnage booked by him than the entire thirty-one dreary days of December. His hope rests on feeble blessings, but he is a true OPTIMIST.

¶ Scuttling Their Own Ship

A SALESMAN whose business judgment is held in great respect brings this instance of the danger of depressing prices. A manufacturer that formerly used a quantity of castings in making certain types of conveying equipment told this salesman that stampings and forgings now are used instead. The reason given was the bidding against each other on the part of foundries was carried to the point that distrust of castings was instilled in the buyer's mind. Perhaps, even, the quality *was* lowered in the mad scramble for this firm's casting business.

WHETHER or not the quality actually was sacrificed, the trust of one customer in the integrity of castings was destroyed and the character assassins were competing foundries. Often, the price cutter meets retribution within the industry. He cuts the price to get a customer from his competitor, who probably has been making castings at a satisfactory price and on a sound business basis for a long period. Perhaps, the cut price makes it imperative for the new seller to shave quality and the business returns to the original source, but probably with the profit impaired. The entire price level is lowered and the confidence of the buyer is wrecked. How much worse this condition becomes when constant battling and repeated cuts in price loses tonnage to the entire industry and throws a libelous inference upon quality of castings.

FORTUNATELY, this instance may be accepted as the exception to the rule. The improvement in quality of castings has been marked even under the past year's reduced business rate. Even with the blind, mad bidding that has obtained, the policy of getting the business and forgetting costs followed by a few firms has not been permitted to militate against making satisfactory castings. The economic adjustment has not intruded in the competitive conditions between industry and industry. Castings *are* maintaining their rightful place and the instance mentioned is only an incident.

¶ Why Group Meetings

AN INTERESTING opinion upon the present value of group meetings in the foundry industry recently was expressed ably by Rex. L. Alexander, president, Olympic Foundry Co., Seattle, Wash., and also president of the Washington Foundrymen's club, as follows:

> We find that the Foundrymen's club, by keeping the men rubbing shoulders during this period of depression, and having something interesting and also worthwhile at each meeting, although not always directly related to foundry problems, brings together and keeps the members of the group on most friendly terms. When business starts on its return to normal or begins to pass "around the corner," the industry as a whole will benefit by the closer acquaintanceship of its members. The club now is able to bind the foundrymen closer together than could be possible during normal times. When times pick up, with that better understanding of the various problems and personalities, the industry in our section will be "rarin' to go."

Industry will need co-operative effort and better understanding during the next few years than at any time in the history of our country. The FOUNDRY agrees with Mr. Alexander that the group meetings, offering a program of interest and also of value, constitute an important part in building for future co-operation.

Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

JOHN R. FRITZ, formerly foundry foreman, Harnischfeger Corp., Milwaukee, has been made foundry superintendent, Manitoba Steel Foundries Ltd., Selkirk, Man., Canada. Mr. Fritz began his foundry work with the Queen City Foundry, Denver, Colo., in 1914, when he served his time under Frank Cordingly. Later when that company was sold to the American Manganese Steel Co., he continued with the American company for two years. He then went to the Pacific coast where he worked for a short period and then became connected with the Harnischfeger Corp., at Milwaukee. Mr. Fritz is a graduate of McLain Systems Inc., Milwaukee.

F. W. Busche, formerly in charge of the brass foundry, Prime Mfg. Co., Milwaukee, has been made vice president and sales manager, Iroquois Foundry, Racine, Wis.

Earl C. Snell has been elected secretary of the Griswold Manufacturing company of Erie, Pa. He has been personnel director. **Charles A. Massing** has been appointed sales manager.

William H. Woodin has been elected president of the American Car & Foundry Motors Co., succeeding C. S. Sale, resigned. The company is controlled by the American Car & Foundry Co., New York, of which Mr. Woodin also is president.

Arthur J. Tuscany, manager, Gray Iron institute, Cleveland, will address the regular monthly meeting of the Quad City Foundrymen's association, to be held Monday evening, Jan. 18, at the Davenport chamber of commerce, on the subject of "The Gray Iron Institute."

Harry Burkhardt recently resigned as foundry superintendent of the Marshall Furnace Company, Marshall, Mich., and expects to leave shortly on a six months' trip throughout the South. Mr. Burkhardt began his foundry career in 1902 and worked in various jobbing shops until 1908 when he became connected with the Monitor Furnace & Stove Company, Cincinnati, as molding machine and core room foreman. He held that position until 1928 when he was made foundry superintendent of the Marshall Furnace company.

Robert H. Morse, formerly vice chairman of the board of directors, Fairbanks, Morse & Co., Chicago, recently was elected president and general manager to succeed W. S. Hovey on his resignation Dec. 1. Mr. Morse was born in Chicago, Dec. 6, 1878. In 1895 he entered the employ of Fairbanks, Morse & Co., the firm founded by his father, C. H. Morse. He began his career with the company as an apprentice at the Beloit, Wis., plant, then known as Fairbanks-Morse Mfg. Co., and, except during his military service, when he was Lieutenant-Colonel in the Signal Corps, has been with the company continuously over a period of 36 years to the present.

Robert H. Morse

Elect Griest President of Malleable Group

At a meeting of the Malleable Iron Research institute, held in Cleveland, recently, the following officers were elected: President, E. E. Griest, Chicago Railway Equipment Co., Chicago; vice president, western section, L. P. Henry, Maumee Malleable Castings Co., Toledo, O.; vice president, eastern section, P. R. Van Duyne, Meeker Foundry Co., Newark, N. J. The directors of the institute for the current year include the following: E. E. Griest, chairman, Chicago Railway Equipment Co., Chicago; H. D. Hunter, Dayton Malleable Iron Co., Dayton, O.; C. L. Liebau, Decatur Malleable Iron Co., Decatur, Ill.; R. E. Bryant, Jefferson Union Corp., Lockport, N. Y.; W. L. Beaudway, Chicago Malleable Castings Co., West Pullman, Chicago; M. B. Falvey, Kokomo Malleable Iron Works, Kokomo, Ind.; H. L. Steeves, Rhode Island Malleable Iron Works, Hillsgrove, R. I.; George R. Metcalf Jr., Erie Malleable Iron Co., Erie, Pa.; L. D. Harkrider, Glancy Malleable Corp., Waukesha, Wis.; R. J. Teetor, Cadillac Malleable Iron Co., Cadillac, Mich.

The meeting was held at Nela Park, the research laboratories of the General Electric Co., Cleveland. Dr. Matthew Luckiesh greeted the guests and delivered an address on "Greater Opportunities for Research." In addition the following papers were presented: "Nonferrous Alloys as Competitive Materials of Malleable Iron; Galvanizing Embrittlement," by Enrique Touceda, consulting engineer; "Budget Results; Current Cost on Basis of Normal Operations," by Robert E. Belt, secretary-treasurer; "Results of Investigation of Machinability of Malleable Iron," by Prof. O. W. Boston, University of Michigan.

Form Local Groups

One local group of the Gray Iron institute recently has been organized in New England, and the organization of three others in the east is being completed, according to Arthur J. Tuscany, Cleveland, manager of the institute. J. D. Coltman, Bullard Machine Tool Co., Bridgeport, Conn., is chairman of the Connecticut group; E. Sessions, Sessions Foundry, Bristol, Conn., cost chairman: Edgar Spencer, Philbrick, Booth and Spencer Inc., Hartford, Conn., merchandise chairman, and W. J. Maton, Waterbury Farrell Foundry & Machine Co., Waterbury, Conn., technical chairman.

Howard A. Stockwell, Barbour Stockwell Co., Cambridge, Mass., is chairman of the Massachusetts-Rhode Island group. Other local groups are being formed in New Jersey and in the Philadelphia area.

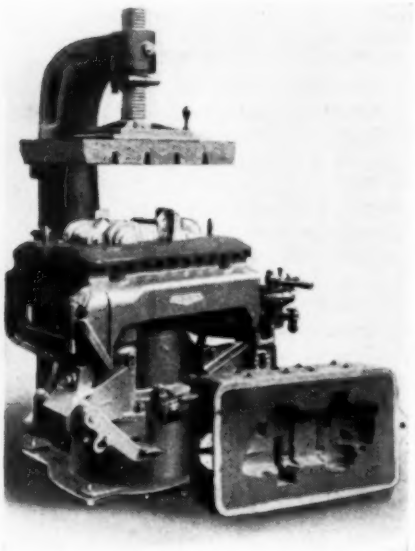
Represent Truck Maker

C. B. Crockett and R. L. Smith have been made eastern general sales agents for the Automatic Transportation Co. Inc., Buffalo. Sales and engineering offices will be maintained in New York with district offices at Boston, Hartford, Conn., Buffalo, Newark, N. J., Philadelphia, Pittsburgh, Washington, Baltimore and Charlotte, N. C. Mr. Crockett formerly was executive secretary, Industrial Truck association, New York, and Mr. Smith was connected with the Elwell-Parker Co., Cleveland.

Fast Operation Features Molding Machine

A new jolt, squeeze, stripper molding machine, recently added to the line of the Osborn Mfg. Co., 5401 Hamilton avenue, Cleveland, embodies many unusual features including fast operation, and adaptability to a wide range of flask sizes and types of patterns.

The post-type squeeze head support requires practically no floor space and



The Machine Is Designed to Utilize a Wide Range of Flasks

is simple in design. The supporting column contains two widely spaced bronze bushings of large area which hold the squeeze heard in alignment during the squeeze operation. An additional ball-type bearing carries the weight of the head when it is rotated into or out of the squeeze position. An adjustable stop permits head-swing to be adjusted to the shortest possible travel for any particular job.

The large screw for vertical adjustment of the squeeze plate rests in a machine steel nut which retains its accurate fit. A positive, quick operating clamp simplifies vertical adjustment of the squeeze plate. The draw mechanism is adjustable from 3 to 6 inches in ½-inch steps. Two rigid arms securely fastened to the frame of the machine automatically fall into position under the lifting frame while the squeeze operation is being performed. The draw commences as soon as the lifting frame makes contact with these arms on the downstroke.

It is claimed that this type of design provides freedom from binding of the frame and aids in obtaining a smooth draw due to the fact that wear, which is the only factor that would affect the accuracy of pattern draw, is uniformly distributed between the two arms. A long, carefully-fitted squeeze piston also adds to the smoothness and accuracy of the draw.

The vibrator is controlled automatically by the motion of the squeeze piston and the operating valve. As the valve is turned to the draw position, the vibrator starts to operate. As soon as the pattern is free of the sand, the downward movement of the table automatically causes the vibrator to cease operation.

The main frame and squeeze head support are a solid one-piece steel casting to give maximum strength, rigidity, and safety. A bushed squeeze cylinder simplifies overhauling when necessary.

An automatic, quick release valve causes the draw to start without delay after the squeeze operation by reducing the high pressure beneath the squeeze piston to an amount just sufficient to support the pattern and equipment, and then slowly exhausting the remainder of the air at a speed that may be adjusted to suit the type of pattern.

Another device, the squeeze pressure relief valve, makes it possible to exert any predetermined amount of squeeze pressure on the mold, regardless of variations in line pressure, provided of course, that the line pressure at no time falls below the pressure to which the valve is set.

Upon completion of the draw operation, the lifting frame is lowered by tripping with a foot lever the two vertical arms which support it during the draw. The drop of the frame is not severe, due to the location of air cushions at the bottom of each guide bushing, against which the guide pins contact.

Push type lubrication fittings are used throughout the machine. The maximum flask length is 30 inches and the maximum flask width 24 inches. The jolt capacity is 700 pounds.

The American Society for Testing Materials, Philadelphia, has published an index to its standards and tentative standards which lists 443 standards and 180 tentative standards in the society's publications.

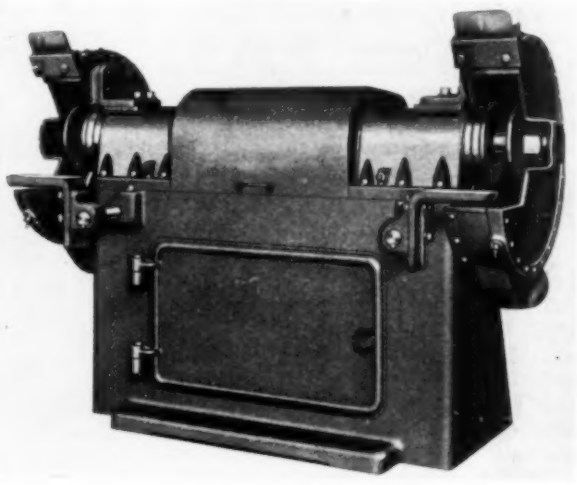
Snagging Grinder Has Independent Speeds

Independent speed control for each grinding wheel is a feature of a heavy-duty, snagging grinder recently introduced by the Hisey-Wolf Machine Co., Cincinnati. Operation of both wheels at the most efficient and economic speed is permitted. Previously, for reasons of safety, it was necessary to determine the speed of the machine by the size of the larger grinding wheel, thus causing the smaller wheel to run too slow. With a wheel at both ends of the spindle the variation in surface speed is marked when one wheel is replaced by a new one of full size while the other wheel still has a few inches of wear before reaching the point where it must be replaced.

The new snagging grinder is manufactured for 20, 24, and 30-inch grinding wheels, either high-speed or vitrified, with spindle speeds to correspond. Ball bearings or roller bearings are optional. Drive is through V-belts, and any stock power motor can be used. Another feature is automatic belt tension adjustment which eliminates motor adjustment.

Merge Instrument Lines

The pyrometer division of the Wilson-Maeulen Co., New York, has merged with the Foxboro Co., Foxboro, Mass., and will be operated as the Wilson-Maeulen Pyrometer division of the Foxboro Co. The entire personnel of the pyrometer division of Wilson-Maeulen will be merged with that of Foxboro, and the instruments will be built in the Foxboro plant. The rockwell hardness testers manufactured by the Wilson-Maeulen Co., hereafter will be built and sold by the Wilson Mechanical Instrument Co., which will maintain its plant at 383 Concord avenue, New York.



The Design Premits Operation of Each Wheel at the Most Economical Speeds

Control Movement of Load in Barrel

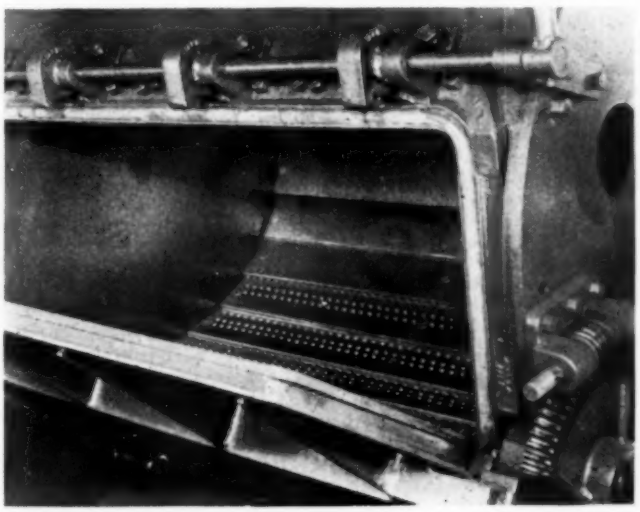
Parsons Engineering Corp., Cleveland, has developed a new blast mill, using either sand or steel abrasive to clean castings and other miscellaneous work. The mill oscillates only through 120 degrees, thus allowing the entrance of a number of either pressure or gravity nozzles along the length of the barrel. The nozzles oscillate with the barrel and direct the blast to the moving center of the load.

The movement of the load is controlled by the lapped lining plates or lifters, shown in the accompanying illustration, which work the castings only on the forward stroke. On the reverse stroke the load slips over the lifters in much the same manner as the operation of a pipe wrench. The fast cascading of the work past the direct blast line of nozzles occurs only for a short period at the top of the forward stroke. During three-quarters of the cycle the mass is moving slowly past the direct blast line, giving a thorough cleaning.

The barrel is supported on heavy duty roller bearings and oscillates ten times per minute. The driving mechanism is fully enclosed and the crank and gears are lubricated by a positive pump and splash oiling system. A special brake mounted on the drive shaft, and direct connected to the motor, stops the barrel at any desired point. The door located at the front of the barrel has a special type of seal and locking device to prevent leakage of abrasive. The door is opened and closed by a worm on the end of the barrel, which locks the door in any position, whether fully or partially closed. The barrel may be oscillated safely with the door in any position without jamming or endangering the operator. The door is not too high for practical operation in loading manually. For loading with a skip or bucket the door may be raised to permit dumping the entire load at once. For unloading, the door is opened and when the barrel is oscillated to a low position, the load is discharged by gravity.

The spent abrasive falls by gravity through perforations in the lining plates into a tight outer cone shaped shell on the under side of the barrel. When the barrel is oscillated, the taper of the cone shell steadily and evenly discharges the abrasive into an enlarged section of the bucket elevator.

Dust caused by the blasting operation is removed by air which enters openings in the barrel at the drive mechanism end and is exhausted from the enlarged elevator section at the opposite end.



Movement of the Load Is Controlled by Lapped Lining Plates Which Work the Castings Only on the Forward Stroke

Moves Eastern Office

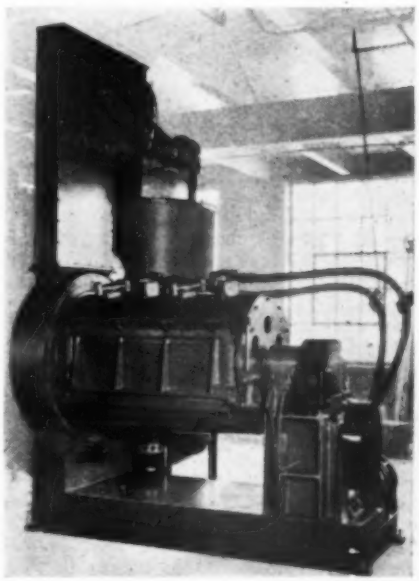
The New England office of the Sterling Wheelbarrow Co., Milwaukee, recently was moved from 141 Milk street, Boston, to the Stearns building, 293 Bridge street, Springfield, Mass. Ray Hunter is manager of the Sterling company in that district.

Uses Vacuum Fusion

Results of an extended study of the vacuum fusion method for the determination of gases in steels are presented in research paper No. 346 published by the bureau of standards. The apparatus has been improved and the analytical procedure simplified as compared to the original method developed by Jordan and Eckman in 1925 and 1927. The method gives values reproducible within 0.002 per cent for oxygen and nitrogen in the absence of interference through the presence of certain difficultly decomposed oxides and certain reactive metallic vapors. The paper may be obtained from the superintendent of documents, Washington, for 10 cents.

Bureau of Standards Issues Report

In the annual report of director of the bureau of standards, Washington, for the period ended June 30, Dr. George K. Burgess reveals that in spite of reduced industrial activities the number of research associates stationed at the bureau by trade and technical associations showed little change. As of June 30, there were 95 associates from 45 associations, as compared with 96 from 41 associations the year before.



Pressure or Gravity Nozzles Enter Along the Length of the Barrel

Principal researches conducted by the metallurgical division in the year included aeration and submerged corrosion, fluidity of liquid metals, shrinkage of molten metals, fatigue of metals—effect of inclusions, bridge wire, rail steel, spark testing of steel and machinability of metals.

Copies of the complete report may be obtained from the superintendent of documents, Washington, for 15 cents.

Study Quenching Media

To determine suitable steel quenching agents with properties between oil and water, tests were conducted at the bureau of standards by T. E. Hamill on aqueous solutions of ethylene glycol, glycerin, and sodium silicate. Ethylene glycol and glycerine gave varying results, but the study indicated that sodium silicate solutions will provide graded cooling speeds between those of water and oil. The data is presented in research paper No. 357, and copies may be obtained from the superintendent of documents, Washington, for 15 cents.

What Others Are Thinking

Abstracts Selected from European Foundry Literature

Resists Corrosion

Austenitic Cast Iron (Les Fontes Grises Austenitiques), by M. Ballay, *La Fonderie Belge*, Liege, Belgium, November, 1931.

Cast irons with an austenitic structure are characterized by their machining properties, and by their resistance to corrosion. According to the author that structure is obtained by the addition of 12 per cent nickel, and two other compositions are mentioned containing respectively 5 to 7 per cent manganese, and 9 to 11 per cent nickel, and 1 per cent manganese and 14 per cent nickel. Tables are included showing the loss of weight of specimens containing 20 per cent monel metal when immersed in sulphuric, hydrochloric, acetic acids, sea water, and subjected to salt water spray. The author states that addition of copper to ordinary cast irons with a pearlitic structure increases resistance to corrosion by acids, especially up to 5 per cent. Further additions have little effect. Nickel increases the solubility of copper in cast irons, and increases the resistance to acids in certain cases. Additions of aluminum and chromium to austenitic cast irons increases the resistance to nitric acid.

Make Plaster Patterns

A New Method to Cheapen Manufacture of Reversible Pattern Plates (Neues Verfahren zur billigen Herstellung von Reversiermodellplatten) by Fritz Brobeck, *Die Giesserei*, Duesseldorf, Germany, Nov. 13, 1931.

The reversible pattern plate referred to is one containing the cope and drag patterns side by side on the same face which necessitates one of the molds being turned 180 degrees in a horizontal plane before placing the two halves together. In making the pattern plate, two flasks and an iron frame are used. In making the pattern plate, a wooden wall is placed in the flasks slightly to one side of the center line. The loose wooden pattern suitably supported to establish the correct parting line, is placed in one section of one of the flasks, and sand rammed around it. The flask is rolled over, the supports removed, and the other flask with a similar wood wall, placed on top. The corresponding section of the flask is filled with sand and rammed. That flask is removed, and laid down so that the cavity is up. The iron frame with a wood divider in the center is placed over the flask, and plaster is poured into that section above the one containing the cavity.

The plaster is allowed to solidify. Then the frame is removed, turned 180 degrees in a horizontal plane, and replaced on the flask. That operation brings the plaster pattern over the empty portion of the flask. The whole now is rolled over, and sand is rammed on the plaster. When the mold is filled with sand, the whole is rolled again, bringing the frame on top once more. The frame is removed. The original loose pattern now is placed in the cavity just made, and that operation brings the opposite side of the pattern up. The other flask now is placed on top so that the empty portion is over the pattern, and it is filled with sand. That flask is removed, and placed on the floor so that the cavity is up.

The frame is taken and placed over the flask just mentioned so that its empty portion is over the cavity. Plaster is poured in and allowed to solidify. Then the frame is removed, and used as the pattern for other molds. Two castings are made in each mold turned out as the plaster plate contains the cope and drag patterns.

Heat Treats Cast Iron

The Heat Treating of Cast Iron (Les Traitements Thermiques des Fontes), by A. LeThomas, *La Fonderie Belge*, Liege, Belgium, October, 1931.

This is the second of two articles and treats of the practical results of graphitization treatments on an iron containing 0.63 per cent silicon; 0.61 per cent manganese; 0.11 per cent sulphur; 0.32 per cent phosphorus, and 3.46 per cent total carbon. Test pieces of 25 millimeters (0.984-inch) square section were heated for 3 hours at 980 degrees Cent. (1796 degrees Fahr.) and the strength ranged from 36 to 41.6 kilograms per square millimeter (51,200 to 59,100 pounds per square inch). The same treatment was used on castings utilized in construction of safety parts in steam turbines. The iron contained 0.77 per cent silicon; 0.44 per cent manganese; sulphur, 0.096 per cent; phosphorus, 0.36 per cent, and total carbon, 3.41 per cent, and the bars 25 millimeters (0.984-inch) square were cast on the casting. The test pieces heated for 5 hours at 950 degrees Cent. (1742 degrees Fahr.) had a strength of 31 kilograms per square millimeter (44,100 pounds per square inch).

Apply Pulverized Fuel

The Application of Pulverized Fuel to the Foundry Industry, by W. Boon, *The Foundry Trade Journal*, London, Nov. 5, 1931.

Equipment installed to fulfill any pulverized fuel application is of first importance. It should be based on experience which would dictate not only the type of machinery, but the method of arrangement and the necesary auxiliaries. Machines on the market may be divided into three main groups: Impact, high speed and attrition mills; ring-roll medium speed grinders; slow speed ball and tube mills. Advantages and disadvantages of these three general groups are summarized. Fundamental considerations, types and characteristics of coals, effect of moisture, centralization versus the unit system and methods of handling the coal also are treated extensively.

Pulverized fuel seems to be an ideal fuel for the malleable iron air furnace. In one installation the fuel to metal ratio varies from 2.5 to 1, to 3 to 1 on a raw coal of the following approximate analysis: Moisture 8.2 per cent, volatile 33.00 per cent, fixed carbon 60.00 per cent, sulphur 0.84 per cent and ash 7.00 per cent.

Extended records kept on a battery of 15 annealing ovens, each of 25 tons capacity shows that the average consumption of the same type of coal is 672 pounds per ton of finished castings. On core ovens a 25 per cent fuel reduction has shown a 50 per cent increase in core output. The most recent development of powdered fuel application is in the rotary melting furnace.

Discuss Low Carbon Iron

Low Total Carbon Cast Irons and Their Service to Foundrymen, by W. West, *Foundry Trade Journal*, Oct. 29, 1931.

An extended series of experiments indicated the fallacy of a popular belief to the effect that shrinkage and contraction effects are due to the silicon content. Innumerable combinations to be obtained from the constituents of cast iron indicate the complex nature of this alloy. During the cooling of any one mixture, only one substance can separate out at one time. In addition to two expansions during the solidification of cast iron due to the separation of primary and secondary graphite, a third expansion occurs with phosphoric irons when the phosphide eutectic is formed. The range of solidification is reduced in proportion to the total carbon content.

The series of experiments indicates that liquid shrinkage is prevented only by having the requisite amount of total carbon present to counteract it by expansion during solidification. An alternative method is to provide risers on the casting of sufficient capacity to feed the sections where liquid shrinkage seems imminent.

Use of low total carbon cast iron is discountenanced in the foundry through the difficulties encountered in foundry practice. Advantages gained outweigh foundry disadvantages only where high test irons are a necessity.

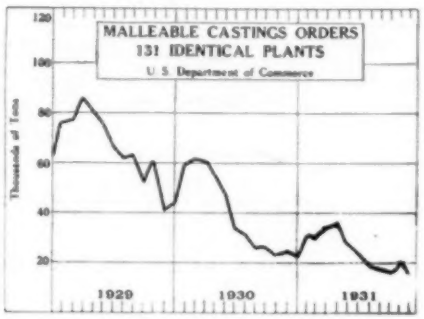
What the Foundries Are Doing

Reflecting the Activities of Gray Iron, Malleable, Steel and Brass Shops

Beloit Iron Works, Beloit, Wis., will build a 2-story addition to its pattern shop at a cost of $40,000.

Freed Heater & Mfg. Co., Collegeville, Pa., has been incorporated with $10,000 capital by Isaac Ash, 1636 Walnut street, Philadelphia.

Mid-West Die Casting Co., 3930 North



First street, Milwaukee, is building a 1-story fireproof shop addition, 23 x 35 feet.

Jenkins Bros. Ltd., Montreal, Que., has completed its first unit of a $2,000,000 plant at Lachine, Que., to be used as foundry and power house.

Waterloo Foundry Co., 1049 Sheffield avenue, Waterloo, Iowa, manufacturer of sash weights and other castings, is building a 1-story foundry addition.

Mt. Vernon Die Casting Corp., 118 Pearl street, Mt. Vernon, N. Y., has acquired the goodwill and dies of the Republic Die Casting Co., 138 Mott street, New York.

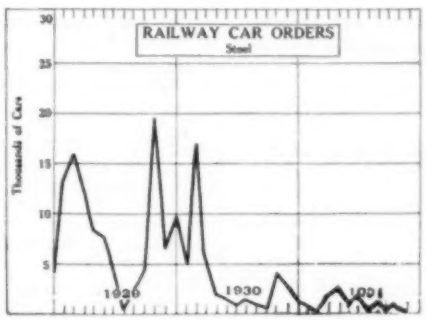
Happy Thought Foundry, Brantford, Ont., a subsidiary of the General Steel Wares Ltd., will remove its equipment to the McClary plant, London, Ont., and will continue the manufacture of stoves and ranges.

Hardie Tynes Mfg. Co., Birmingham, Ala., has shipped the last two of 18 sluice gates for the New York City water supply system. The gates weigh 15 tons each and are built up of steel, iron and bronze.

Iroquois Foundry, Reichert court, Racine, Wis., has added a separate unit to its iron foundry for the manufacture of brass and aluminum castings. Robert Neiss, president, advises that no new equipment will be needed for the new division.

Lycoming Mfg. Co., Williamsport, Pa., a division of the Cord Corp., the first of the month announced an immediate increase of 100 per cent in foundry production to meet requirements necessitated by the volume of orders for passenger car, aircraft and truck engines now in hand. Foundry output, which has been at 75 tons daily since the first of December, was to be increased to 150 tons daily.

While foundry production was scheduled to increase by mid-January in the Chicago area, particularly among the western Michigan automotive casting shops, activity at the beginning of the month was at about 20 per cent of capacity. A number of plants closed over the holiday period until early in January. Aluminum foundry schedules had been relatively active, due largely to



demands of the kitchenware industry, but were curtailed early in the month because of inventories.

Trade Publications

SOLVENTS—The Roessler & Hasslacher Chemical Co., Niagara Falls, N. Y., has published two pamphlets on the solvents it manufactures for degreasing metals and other materials, and for other uses. One pamphlet presents the features, uses and applications, and the properties of trichlorethylene. The other pamphlet describes carbon tetrachloride, dichlormethane, tetrachlorethylane, dichlorethylene, etc.

METALLOGRAPHIC EQUIPMENT—The Bausch & Lomb Optical Co., Rochester, N. Y., recently has published a 125-page catalog showing its optical instruments for examining and analyzing metals. Illustrations of the apparatus and plates showing the results obtained are displayed. In addition articles giving useful information for metallographers are included.

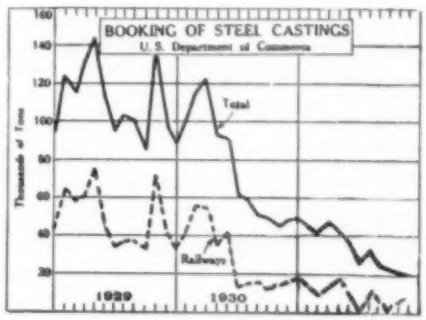
WELDING—Linde Air Products Co., 30 East Forty-second street, New York, in a current bulletin announces a newly devised welding appliance for rapid welding with lessened effort. The device is illustrated and a description of its operation is given.

FURNACES—Technical information on physical factors affecting production of uniformly heat-treated products, frequently not considered in practice, is included in Bulletin No. 318 by the W. S. Rockwell Co., 50 Church street, New York.

TRANSMISSIONS — Reeves Pulley Co., Columbus, Ind., in catalog No. 99 describes its complete line of variable speed transmissions. It shows 16 designs, describes new designs and remote controls, automatic control by electrical and mechanical means and gives suggestions as to various applications. Engineering data are included.

HOISTS AND CONVEYORS—Wright Mfg. Co., Bridgeport, Conn., has issued a condensed catalog, covering its entire line of hoisting and conveying equipment, with a brief description of each unit. The catalog covers hand operated chain hoists, trolleys, trolley hoists, traveling and jib cranes and electric hoists.

REFRACTORIES—A catalog issued by the McLeod & Henry Co., Troy, New York, manufacturer of furnace refractories, describes various types of refractory blocks, bricks and complete settings of a silicon-carbide refractory developed by this company. Physical characteristics and manufacturing processes are described in detail and its advantages, limitations and high-temperature applications in lining boilers, industrial furnaces, kilns, retorts, muffles, are discussed.



RAW MATERIAL PRICES

Jan. 6, 1932

Iron	
No. 2, foundry, Valley	$15.50 to 16.00
No. 2 Southern, Birmingham	12.00
No. 2 foundry, Chicago	16.50
No. 2 foundry, Buffalo	16.00
Basic, Valley	15.00
Basic, Buffalo	15.50 to 16.00
Malleable, Chicago	16.50
Malleable, Buffalo	16.50
Coke	
Connellsville Beehive coke	$3.25 to 4.50
Wise county beehive coke	4.25 to 5.00
Detroit by-product coke	8.00
Scrap	
Heavy melting steel, Valley	$9.00 to 9.50
Heavy melting steel, Pitts.	10.00 to 10.25
Heavy melting steel, Chicago	7.50 to 8.00
Stove plate, Buffalo	8.25 to 8.75
Stove plate, Chicago	6.25 to 6.75
No. 1 cast, New York	7.00 to 7.50
No. 1 cast, Chicago	8.00 to 8.50
No. 1 cast, Philadelphia	11.50
No. 1 cast, Pittsburgh	10.00 to 10.50
No. 1 cast, Birmingham	9.00 to 10.00
Car wheels, iron, Pittsburgh	10.00 to 10.50
Car wheels, iron, Chicago	8.50 to 9.00
Railroad malleable, Chicago	7.00 to 7.50
Agricultural mal., Chicago	7.00 to 7.50
Malleable, Buffalo	9.75 to 10.25
Nonferrous Metals	**Cents per pound**
Casting copper, refinery	7.00
Straits tin	21.12½
Aluminum, No. 12, producers	22.00
Aluminum, No. 12 remelt	8.50 to 9.50
Lead, New York	3.75
Antimony, New York	6.15
Nickel, electro	35.00
Zinc, East St. Louis, Ill.	3.10 to 3.12½

WHERE-TO-BUY

A classified list of advertisers according to products. ¶Index to advertisements give page number of any advertiser.

ABRASIVE WHEELS

Haskins, R. G., Co., 4635 West Fulton St., Chicago, Ill.
Safety Grinding Wheel & Machine Co., Springfield, O.

ABRASIVES—Metallic

American Steel Abrasives Co., Galion, O.
Globe Steel Abrasive Co., Dept. F., Mansfield, O.
Patch-Wegner Co., Inc., Rutland, Vt.
Pittsburgh Crushed Steel Co., Pittsburgh, Pa.
Steel Shot & Grit Co., Amesbury, Mass.
Steelblast Abrasives Co., 6536 Carnegie Ave., Cleveland, O.

ACETYLENE DISSOLVED OR IN CYLINDERS

Linde Air Products Co., 30 E. 42nd St., New York City.

ACETYLENE GENERATING APPARATUS

Linde Air Products Co., 30 E. 42nd St., New York City.

ALKALI

Mathieson Alkali Wks., Inc., The, 250 Park Ave., New York, N. Y.

ALLOYS

Driver-Harris Co., Harrison, N. J.
Electro Metallurgical Sales Corp., 30 E. 42nd St., New York City.

ARRESTORS & COLLECTORS—Dust—See Dust Arresting and Collecting Systems

BABBITT METAL

Ajax Metal Co., 46 Richmond St., Philadelphia, Pa.

BARS (Steel)

Bethlehem Steel Co., Bethlehem, Pa.

BELLOWS—Molders

Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.

BOLTS AND NUTS

Bethlehem Steel Co., Bethlehem, Pa.
Driver-Harris Co., Harrison, N. J.

BOOKS—Technical

Penton Publishing Co., Cleveland.

BOTTOM PLATES—Steel

Truscon Steel Co. (Pressed Steel Div.) 6100 Truscon Ave., Cleveland, O.

BRONZE—Manganese

Ajax Metal Co., 46 Richmond St., Philadelphia, Pa.

BRUSHES—Foundry

Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.

BRUSHES—Motor and Generator

United States Graphite Co., The, Saginaw, Mich.

BUCKETS

Penn Foundry & Mfg. Co., Reading, Pa.

BUCKETS—Clamshell, Dragline, Grab

Brosius, Edgar E., Inc., 19th St. & P. R. R., Sharpsburg P. O., Pittsburgh, Pa.

BUILDINGS—Foundry, Factory, Industrial

Austin Co., The, 16112 Euclid Ave., Cleveland, O.

BURNERS—Oil or Gas

Foundry Equipment Co., The, 1831 Columbus Rd., Cleveland, O.

BUSHINGS—Flask Pin

Michigan Screw Co., Lansing, Mich.

CALCIUM—SILICON

Electro Metallurgical Sales Corp., 30 E. 42nd St., New York City.

CALCIUM CARBIDE

Linde Air Products Co., 30 E. 42nd St., New York City.

CARBIC

Linde Air Products Co., 30 E. 42nd St., New York City.

CARBIDE

Linde Air Products Co., 30 E. 42nd St., New York City.

CARS—Platform, Industrial Railway, Transfer, Narrow Gage

Bethlehem Steel Co., Bethlehem, Pa.
Foundry Equipment Co., The, 1831 Columbus Rd., Cleveland, O.
Penn Foundry & Mfg. Co., Reading, Pa.

CARS & LOCOMOTIVES—Industrial

Industrial Equipment Co., The, Minster, O.

CASTINGS (Gray Iron)

Bethlehem Steel Co., Bethlehem, Pa.

CASTINGS (Heat Resistant)

Driver-Harris Co., Harrison, N. J.

CASTINGS (Nickel Chromium)

Driver-Harris Co., Harrison, N. J.

CEMENT—High Temperature, Refractory

Alpha-Lux Co., Inc., 192 Front St., New York City.

CHAINS (Crane & Slings)

Newhall Chain Forge & Iron Co., 9-15 Park Place, New York, N. Y.

CHALKING HAMMERS—Pneumatic

Independent Pneumatic Tool Co., 600 W. Jackson Blvd, Chicago, Ill.

CHEMICALS

Mathieson Alkali Wks., Inc., The, 250 Park Ave., New York, N. Y.

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COAL CRUSHERS and Pulverizers

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COAL—ORE—ASH HANDLING MACHINERY

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Shepard-Niles Crane & Hoist Corp., Shepard Crane & Hoist Div., 358 Schuyler Ave., Montour Falls, N. Y.

COKE

Bethlehem Steel Co., Bethlehem, Pa.
Hanna Furnace Corp., The, Detroit, Mich.
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Jeffrey Mfg. Co., The, Columbus, O.
Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.

CORE BINDERS

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Smith, Werner G., Co., 2191 W. 110th St., Cleveland, O.

CORE BREAKERS

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CORE COMPOUNDS

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Pennsylvania Lubricating Co., 34th & Smallman Sts., Pittsburgh.
Smith, Werner G., Co., 2191 W. 110th St., Cleveland, O.

CORE MAKING MACHINES

Arcade Mfg. Co., Dept. D, Freeport, Ill.
Demmler, Wm., & Bros., Kewanee, Ill.
Herman Pneumatic Machine Co., Union Bank Bldg., Pittsburgh.
International Molding Machine Co., 2616 W. 16th St., Chicago, Ill.
Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.
Tabor Mfg. Co., The, 6225 Tacony St., Philadelphia, Pa.

CORE OIL

Lindsay-McMillan Co., 930 S. Water St., Milwaukee, Wis.
Smith, Werner G., Co., 2191 W. 110th St., Cleveland, O.

CORE OVENS—See Ovens—Core-Mold

CORE RACKS

Foundry Equipment Co., The, 1831 Columbus Rd., Cleveland, O.
Truscon Steel Co. (Pressed Steel Div.) 6100 Truscon Ave., Cleveland, O.

CORE RODS

Franklin Core Rod & Gagger Co., Franklin, Pa.

CORE ROOM EQUIPMENT

Truscon Steel Co. (Pressed Steel Div.) 6100 Truscon Ave., Cleveland, O.

CORE WASH

Dixon, Joseph, Crucible Co., Jersey City, N. J.
Pettinos, Geo. F., Inc., 1206 Locust St., Philadelphia, Pa.
United States Graphite Co., The, Saginaw, Mich.

CRANES

Shepard-Niles Crane & Hoist Corp., Niles Crane Division, 358 Schuyler Ave., Montour Falls, N. Y.
Shepard-Niles Crane & Hoist Corp., Shepard Crane & Hoist Div., 358 Schuyler Ave., Montour Falls, N. Y.